Regulatory Acceptance for New Solutions

INTERSTATE TECHNOLOGY REGULATORY COUNCIL

ITRC

New Jersey Brownfield Program

New Jersey and the Interstate Technology and Regulatory Council

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ITRC Brownfields Program

- Brownfield Team to address large number of brownfield related issues in the remediation and reuse of contaminated sites with the implementation of innovative technologies and approaches

ITRC Brownfields Program

- Current Project includes
  - Brownfield Case Studies (received over 35 case studies from across the country)
  - Narrow list to a short list of 11 sites
  - Case studies of 11 sites to focus on
    - environmental issues
    - innovation
    - public participation
    - economics
    - what worked/what didn't

ITRC Brownfields Program

- Future projects include
  - Dynamic workplan study
    - Triad approach to cleanups
  - Indoor air issues
  - Long term stewardship of institutional/ engineering controls
- For additional info: www.itrcweb.org

Sampling, Characterization, & Monitoring Team

Value: Addresses innovations and paradigm shifts in sampling and monitoring related to real-time information, continuous monitoring, and monitoring for site closure and long-term stewardship

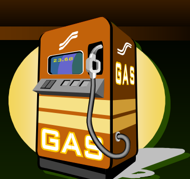
Lead: Stuart J. Nagourney, NJDEP

Members:
- 9 State Agencies
- EPA
- DOD
- DOE
- Academia
- Industry

Sampling, Characterization, & Monitoring

Team Objectives And Deliverables

- Prepare inventory of FAMs and associated QA guidelines for use
- Develop TRIAD guidance document from state agency perspective
- Create a template for case study presentations
- Promote new analytical methods
- Prepare materials for Internet and classroom training



Field Analytical Methods

Field methods (for all matrices) can be used for the following conditions:

- For contaminant delineation, if contaminant identity is known
- For SI sampling (10+ samples); to verify that up to 50% of samples are clean
  - Lab confirmation for 50% of samples

Field Analytical Methods

Field methods shall NOT be used:

- To verify contaminant identity
- To verify clean zones

ITRC Contacts

Web Site: http://www.itrcweb.org

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SCM Team Leader:

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Presentations

Understanding the Importance of Innovative Approaches in a Redevelopment Setting
Dan Powell, Technology Innovation Office, USEPA

Use of the Dynamic Work Planning at the Fairfield Textiles Site in New Jersey
Ken Siet, Dan Raviv Associates

Use of Triad Approach to Investigate Properties in the Assumpink Creek Greenways Project
Jim Mack, New Jersey Institute of Technology

Data Quality: Closing the Decision-Data Loop
Deana Crumbling, Technology Innovation Office, USEPA

Advancing the Reuse Agenda: *A Triad Approach to Effective Site Cleanup*

Daniel M. Powell
U.S. EPA, Technology Innovation Office
powell.dan@epa.gov

Brownfields to "Reuse"

- Multiple reuse initiatives, efforts, programs, etc.
  - » Brownfields (National)
  - » Superfund site recycling
  - » USTFields
  - » RCRA Brownfields
  - » Base Realignment and Closure ("Federal Brownfields Sites")
  - » State programs
    - —Voluntary Clean-Up Programs
    - —Brownfields
    - —State clean-up "Superfund"
  - » Private sector

The Land Reuse Equation

Purchase Costs + Redevelopment Costs [Clean Value

- •Transaction costs
- •Site prep
- •Construction
- •Development
- •Taxes/admin.
- •Marketing
- •Etc., etc., etc.

+

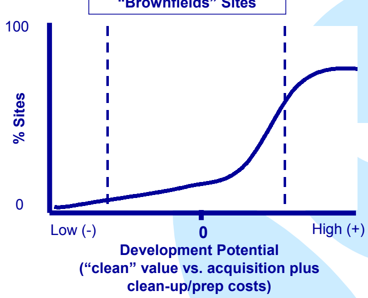
- •Assessment
- •Cleanup
- •Liability issues

- •Revenues
- •Resale/asset value
- •Social/political

The Reuse/Technology Nexus

- *Technologies can support successful redevelopment at Brownfields:*
  - » **By changing standard assumptions of what is possible:**
    - —**Cost**
    - —**Time**
    - —**Site conditions, issues, etc.**
  - » **By affecting decisions:**
    - —**Purchase price + site prep ["clean" value**
    - —**Site prep includes investigation and clean-up (risk management)**
    - — **Lower costs can significantly affect equations**
      - –**More "positively positioned" properties**
      - –**More "public" redevelopment**

Theoretical Distribution of "Brownfields" Sites



Potential with innovative approaches?

Innovative Analytical and Sampling: Opportunities for Cost Savings, <u>TODAY</u>

- An excellent target for innovative approaches
  - » Available today
  - » Impacts <u>total</u> project costs
  - » Results in "remedy" savings (*e.g.* removal, treatment)
- All sites require monitoring and measurement activities
  - » Public lead, private lead
  - » High value, low value, no value (redevelopment perspective)
  - » Big sites, small sites
  - » Clean-up, "no further action" sites
- Monitoring and measurement activities occur from site assessment through site closeout, reuse

Understanding the Context of Cleanup

Reuse Plans, Goals

Drive

Decisions:
- Cleanup goals
- Data (type, quality)
- Tolerable uncertainty

Determine

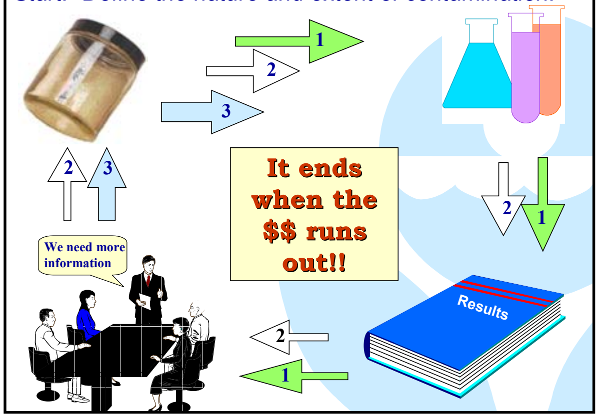
Approaches to:
- Assessment
- Investigation
- Cleanup Design, Implementation
- Closeout, Long-Term Operations and Maintenance

Tools for:
- Sampling and Analysis
- Cleanup/Remediation
  - Containment
  - Cleanup
  - Controls
- Monitoring, maintenance

Planning is the Key to a Rational Cleanup Process

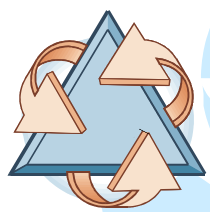
- Identify key decisionmakers, decisions and data needs of each
- Include their upfront input on goals, decisions from decisionmakers THROUGH planning process
  - Consensus
  - Commitment
- Actively address uncertainty and all sources of uncertainty (tolerable to decisionmakers)
- Site-specific approaches to all activities
- Focus on goals of reuse and site activities build and advance towards goals

Start: "Define the nature and extent of contamination."



The Triad Approach

Systematic Planning



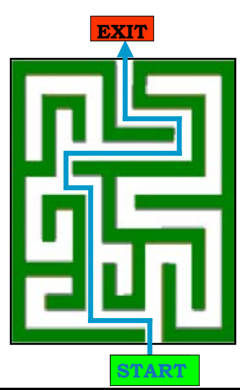
Dynamic Workplanning

"Near Real Time" Measurement Technologies

Characteristics of the "Triad"

- Fully maximizing capabilities of **field analytical instruments** and rapid sampling tools
- **Systematic planning**
  - Meeting site or project-specific goals vs. prescriptive methods "checklists"
  - Relying on thorough advance planning/up-front understanding of the site
  - Global view of project, ultimate goals
- **Dynamic** or adaptive decision making
- Bringing together the right **team**
- Changing **perception**
  - Requirements for accurate, protective, and defensible decisions
  - Time, money, and quality

Core Concept: Systematic Planning



- Stakeholders involved
- Multidisciplinary Team
- Exit strategy clearly defined
  - Identify project decisions
  - Identify desired certainty
- Project-specific Conceptual Site Model (CSM)
  - Identifies data/information gaps
  - Data collection supports evolution of CSM as data/information gaps filled
- Identify most resource-effective means to fill data/information gaps

Core Concept: Dynamic Work Plans

- Real-time, decision-making in the field
- Real-time analysis makes possible, field analytics makes economical
- Experienced, senior technical personnel (scientists & engineers) in the field
- Regulator-approved decision trees
  - Flexible work plans
    - Alternate contracting options
    - Regulator, senior staff involvement
  - Adaptive sampling and analysis plans
  - Evolve the CSM to maturity
- Seamless flow of site activities → fewer mobilizations

Core Concept: Real-Time Analytical and Sampling Technologies

- Field analytical, rapid sampling, mobile labs, quick turnaround off-site all allow real-time or near real time analysis
- Rapid turnaround results support dynamic decisionmaking
- Lower costs of field methods support increased density (address sampling uncertainty)
- Field results guide confirmation (address analytical uncertainty)
- Decision support software can help organize and process data, plan field activities

Core Concept: Real-Time, On-site Analytical and Sampling Technologies

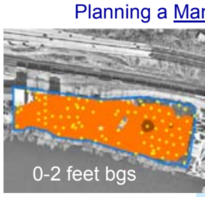
- Field Gas Chromatograph/Mass Spectrometry (rugged, portable, quality data in field)
- Field X-Ray Fluorescence (rapid, field analysis of a variety of metals, including lead paint chips)
- Immunoassay (kits for variety of contaminants, e.g., PCBs, in multiple media)
- Laser Induced Fluorescence (real time analysis, applicable to petroleum hydrocarbons, PAHs)

Core Concept: Real-Time, On-site Analytical and Sampling Technologies

- Direct push sampling (versatile, quick, inexpensive, "clean")
- Geophysics (underground objects, including tanks, unexploded ordnance)
- Decision support software (supports rapid interpretation of field data)

Decision Support Tools

Visualizing Contaminated Soils-
Planning a <u>Manageable</u> Cleanup



Fully Integrated Environmental Location Decision Support (FIELDS) System

www.epa.gov/region5fields

Themes

- Bottom line: Improve environmental decisionmaking by providing data to support protective, effective environmental decisions (**"Better"**)
- Reduce program and compliance timeframes and costs (**"Faster" and "Cheaper"**)
- Focus on site-specific decision needs and utilize best mix of sampling, analytical, and decision tools and strategies to meet those needs (**"Smarter"**)

Themes

- Redirect emphasis:
  - » Actively address and manage all sources of uncertainty (analytical AND sampling)
  - » Improve understanding of terminology (e.g., data vs. methods, screening vs. definitive)
  - » Pick best method for site, decision needs vs. over-reliance on “approved” methods
- Not an indictment of past practice
- Impetus to align practice with current knowledge, technology capabilities

Why “Innovate?”

- Not new, not unproven
  - » Expedited approaches developed with years of experience
  - » “Pockets” of success among practitioners
- Technology improvement allows change
  - » Increasing capabilities for on-site measurement technologies to provide decision quality data
  - » Ability to address issue of representative sampling affordably
- Changing focus of programs
  - » From enforcement mindset
  - » To Brownfields, economic redevelopment
  - » To voluntary cleanup
  - » To compliance assistance

Connecting the Triad and Brownfields
A Marriage of Necessity

- Focus on time, money but need defensible decisions
- Focus on reuse goals: site end-use creates discipline for systematic planning
- Less segmented, compartmentalized approaches. Continually building on data (old and new) is the key to affecting total costs
- As move from “low hanging fruit” to less straightforward sites, need for innovation increases
- Rural, poorer communities may not have as much money to leverage: maximize assistance funds

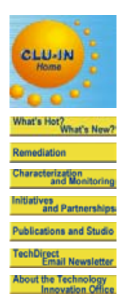
Brownfields and Triad
Needs, Moving Forward

- Procurement process essential - need expert advice in building, evaluating RFPs
  - » Must accommodate systematic planning process
  - » Must recognize existing information/data
  - » Must be able to judge different approaches
  - » Data users need to review approaches up-front
  - » Require key decisionmaker involvement during field work
- Limited number of “experts:” must consider innovative staffing, management tools to use limited resources (analogy- surgeons vs. EMTs)
- Batching small sites a perfect opportunity to make technologies, approaches economical

Brownfields and Triad
Needs, Moving Forward

- Building infrastructure
  - » Training
    - —Classroom
    - —Internet
    - —Partners
      - –ITRC
      - –NEWMOA
  - » Tech Support
    - —EPA
    - —Other Feds
    - —HSRCs, other non-Federal
  - » Policy, guidance, references
- Groundwater/DNAPL - shortening timeframes

Resources: General



- Hazardous Waste Clean-Up Information (CLU-IN) Internet site (http://clu-in.org)
  - —Go to “Characterization and Monitoring” link
  - —“TechDirect Email Newsletter” for automatic updates on new resources

Resources - General

Brownfields Technology Support Center
http://www.brownfieldstsc.org

- Publications
- Request site-specific support (Federal, state, local personnel)
- Reports on past projects
- Events

Thank You

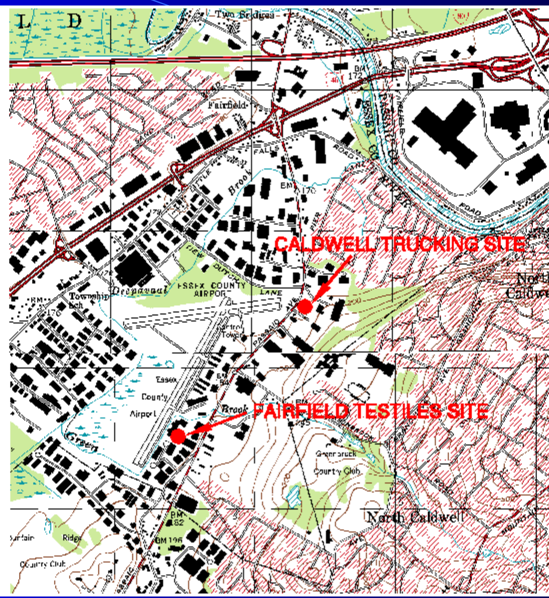
FAIRFIELD TEXTILES SITE
FAIRFIELD, NEW JERSEY

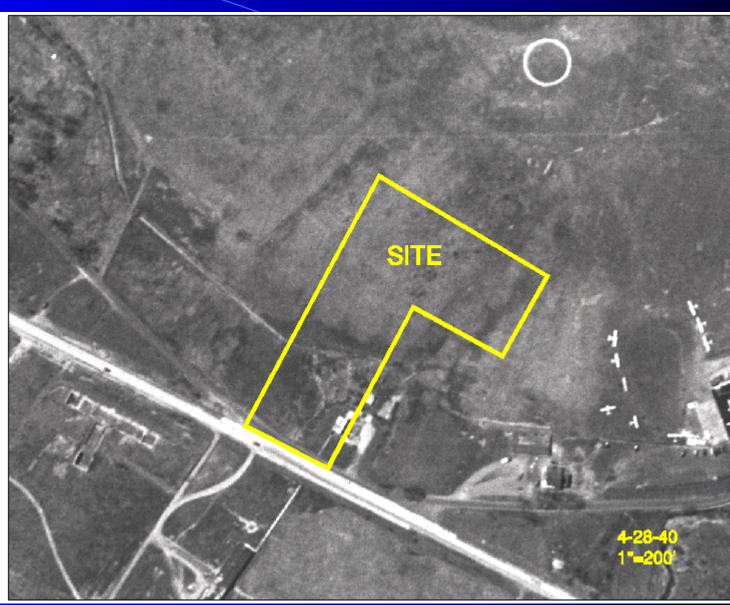
- Manufactures textile products since 1972
- Site Approximately 4 acres
- Historically, some textiles were dry cleaned on-site using PCE (dry cleaning recently ceased)
- Dirty PCE was recycled on-site (95%) via distillation
- Virgin PCE was kept on-site in 2,000 gal tank
- Wastewater was discharged to Green Brook until 1979
- Wastewater was then discharged to a concrete pit located inside the building

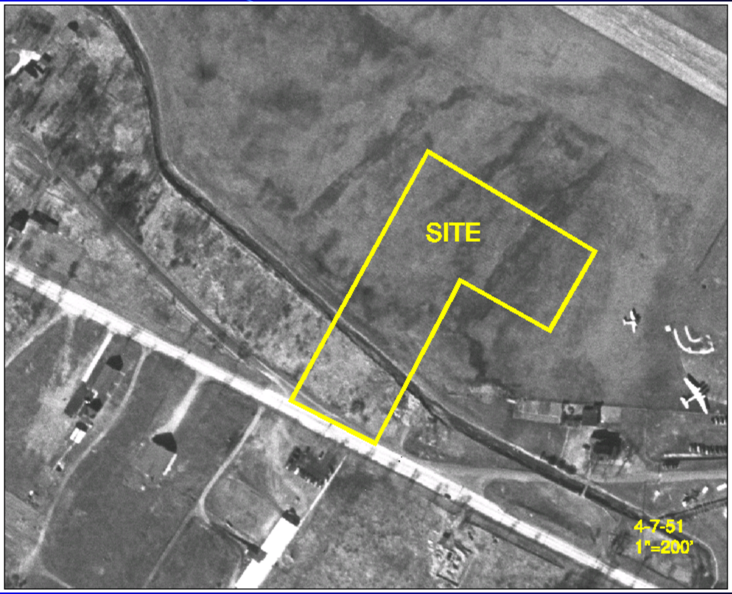
DRAI 1

- The facility is located adjacent to County Airport
- A stream (Green Brook) lies immediately west of the site
- A municipal water supply well is located approximately 500 feet from the site
  – This well is contaminated with chlorinated volatile organics (CVOs), including PCE (NPL)
- Other known contaminated sites in the immediate area include the Caldwell Trucking Site (NPL) and the Cooper Industries Site (CVOs)

DRAI 2


CALDWELL TRUCKING SITE
FAIRFIELD TESTILES SITE
Two Bridges
Fairfield
North Caldwell


SITE
4-28-40
1"=200'

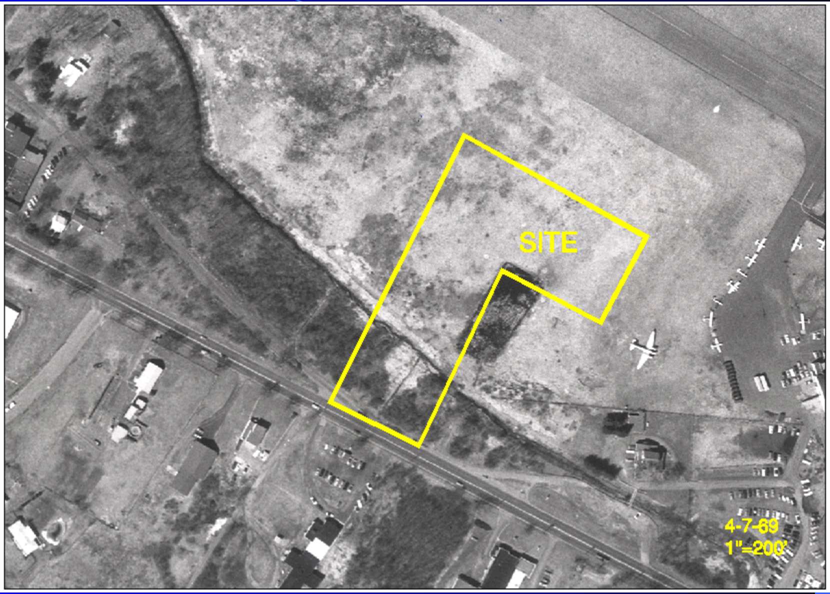


DRAI

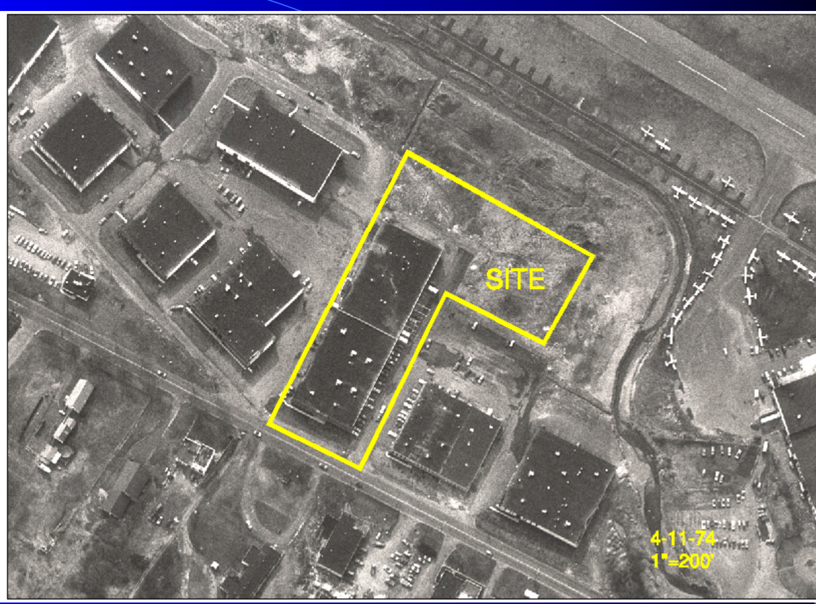
5

DRAI

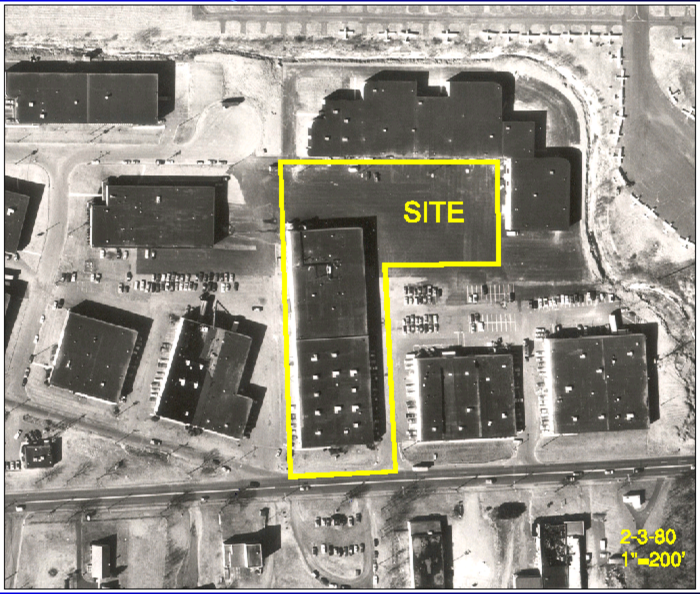
6



DRAI 7



DRAI 8



- Chlorinated hydrocarbons were found in ground water at the site by NJDEP during 1994 and 1996 site assessments
- The Facility entered into an ACO with NJDEP in May 2000

Geology

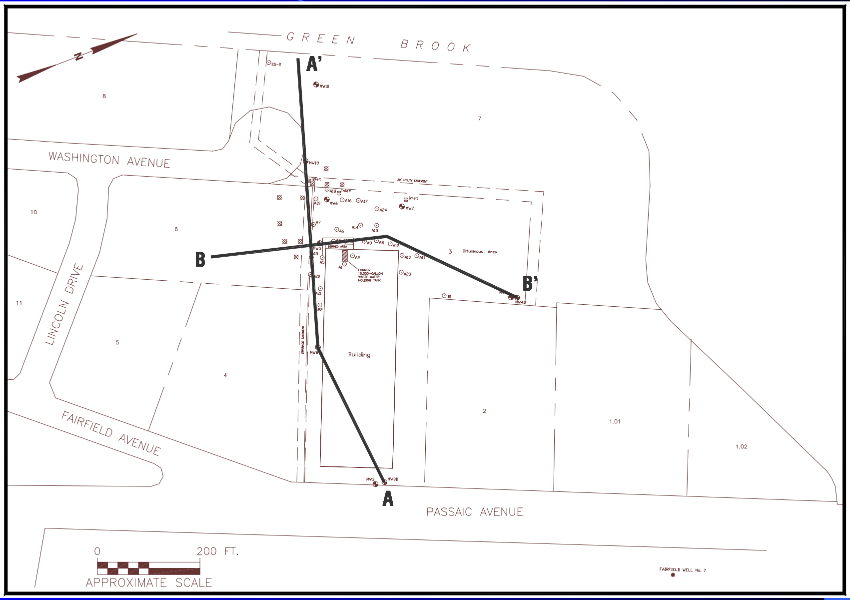
- Area formerly occupied by ancient Lake Passaic
- Overburden
  - 40 to 50 feet of glacial deposits
    - Lacustrine sediments(fine sand silt clay), overlying
    - Glacial outwash (course sand, gravel and cobbles)
- Bedrock (lower Jurassic age basalt) at approximately 50 feet bgs

DRAI 11

BASIC HYDROGEOLOGY

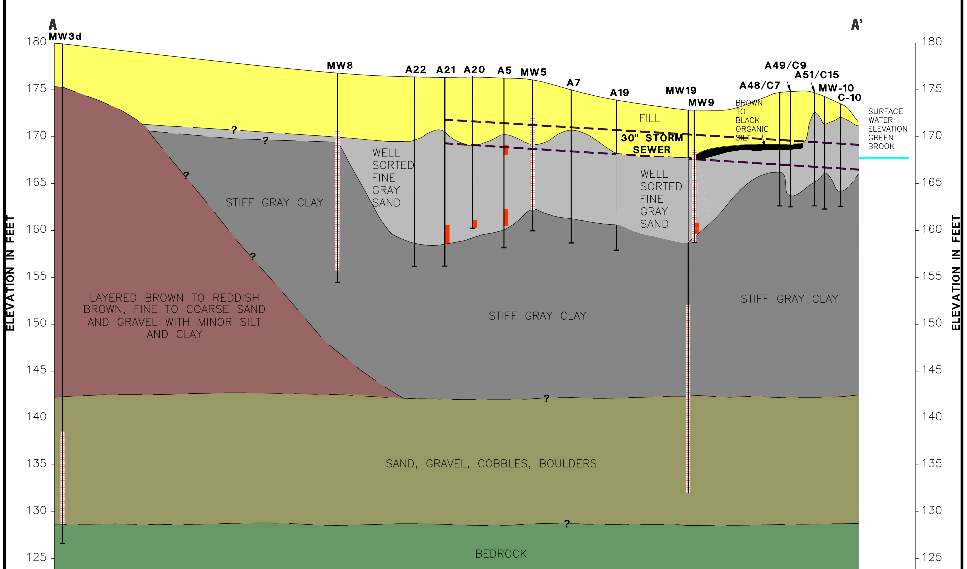
- Two water bearing zones in overburden
  - Shallow zone (water table at +/-5 feet bgs) within fine sand deposits
  - Deeper zone within courser deposits immediately above bedrock
  - Water bearing zones seperated by 12-18 ft of clay (confining unit)
- Ground water flow direction is to the west, towards Green Brook

DRAI 12



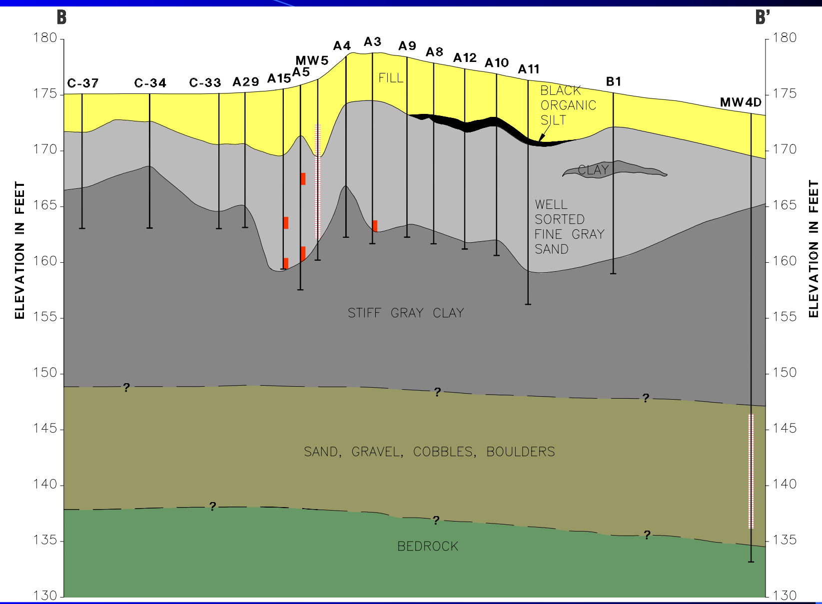
DRAI

13



DRAI

14



REMEDIAL INVESTIGATION

- Conducted in two phases
  - Initial Phase (initial site characterization PA/SI)
    - 6 shallow zone wells
    - 2 deep overburden wells
    - 24 soil borings
  - Delineation Phase (delineate product and clean zone)
    - On-site mobile laboratory
    - Geoprobe drill rig, PID, Sudan IV
    - 34 soil borings and 56 ground water samples
    - Some ground water samples from multiple depths

Delineation Phase

- Purpose: Complete delineation in 1 phase
  - Meet RI requirements of N.J.A.C. 7:26E-4
  - Delineate product in unsaturated and saturated zone (PCE)
  - Delineate contaminated soil
  - Delineate dissolved phase plume
  - Evaluate migration pathways
  - Obtain sufficient data to implement short (Free Product IRM) and long term remidies
- A mobile lab (STL On-Site Technologies) was brought on-site for 13 days

28’ Fifth Wheel Trailer

DRAI 19

Field Analysis During RI

- Field Lab with GC on-site 13 days
- Soil samples collected using Geoprobe, continuous macro-core
- Ground water samples collected using Geoprobe drive point with 2 ft screen
- Field screen using PID and Sudan IV for product (Sudan IV carcinogen)
- Lab was capable of running up to 20 VOC analysis per day (Lesson Learned)
- When clean zoned reached confirmatory soil sample was taken for off-site analysis

DRAI 20

Mobile Lab Interior - LI, NY VOC
Plume Delineation Project

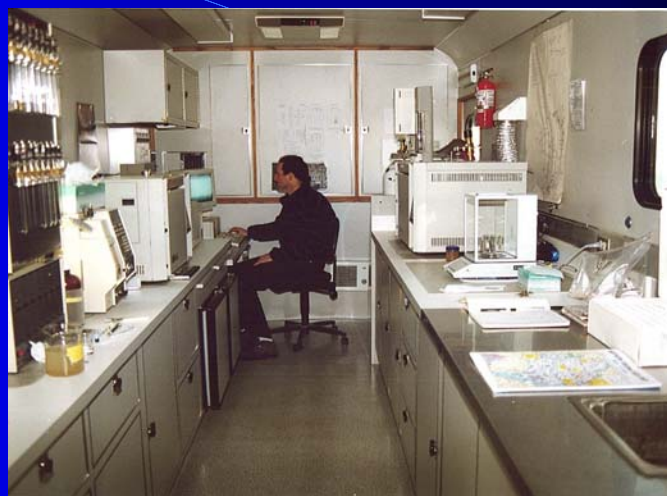
DRAI

21

Mobile Lab Interior - VOCs by GC ELCD/PID

DRAI

22



Mobile Lab Interior - set up for Volatile Organic Compounds by method 8021

DRAI 23

MOBILE LAB ADVANTYAGES

- Rapid turnaround: most cases same day
- Allowed for “real time” decision making
- Delineation expedited
- More samples analyzed than in traditional RI
- Reduced Mobilization Costs
- Mobile labs usually charge based on daily rate, not per sample (we paid $1,200/day including operator, 10 hour day)
- Compared to off-site 24 hr lab turn-around
- Could reduce analytical costs

DRAI 24

28’ Fifth Wheel Trailers

DRAI 25

DISADVANTAGES

- Your paying for downtime. Drilling crews often encounter mechanical difficulty.
- First day lab required most of the day to set up and calibrate equiptment
- Samples had to be re-run at different dilution factors
- **Mobile lab was not NJDEP Certified**
- Required greater coordination with NJDEP case manager (trust factor)
- Required experienced higher level geologist and helpers on-site
- Confirmatory soil samples still had to be sent to off-site lab

DRAI 26

DRAI 27

OTHER CONSIDERATIONS

- Complete thorough PA/SI
- Understand objectives before going out to the field
- There was very good correlation between results from mobile lab and certified off-site lab
- Pre-screen samples to reduce dilution re-runs
- Consider using two rigs to maximize abilities of mobile lab. We rarely exceeded 50% of mobile labs capacity.
- Communications: Mobile phones, beepers are a must.
- Have change orders ready
- Expect longer days – planning meeting at end of each day

DRAI 28

Results of RI

- Product (CVOs) identified in 10 borings and one monitoring well (out of a total of 104 borings and 10 wells)
- Product was typically found sitting on top of the clay confining unit- horizontally delineated in shallow water bearing zone
- Geology (clay unit topography) critical
- Vertical delineation of product was not completed

DRAI 29

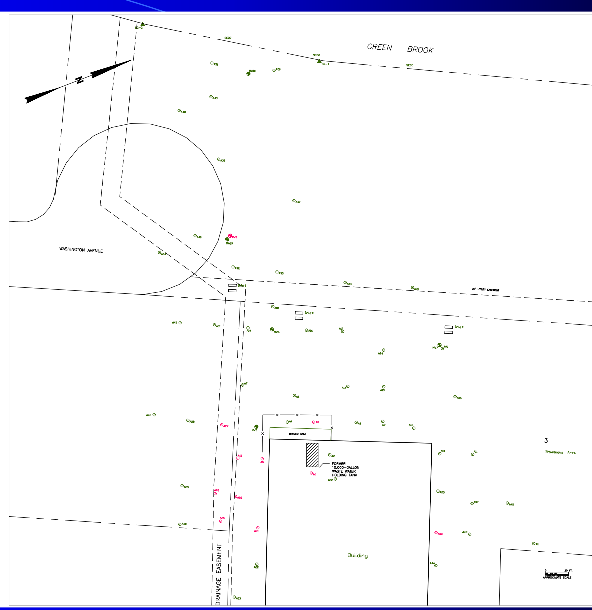
Results of RI

- Soil Sampling Results
  - Cis -1,2-DCE, TCE and PCE detected at suspected source areas in excess of NJDEP IGWSCC
  - Soils Delineation Complete
- Ground Water Results
  - 1,1-DCE, cis-1,2-DCE, TCE, VC and PCE exceed Class II-A GWQS
  - Shallow Dissolved plume(s) deleneated, extends to Green Brook
  - An off-site existing well within the plume area is not double cased
  - Higher piezometric head in deep overburdon zone
  - Vertical delineation not completed
- Product Delineation Complete

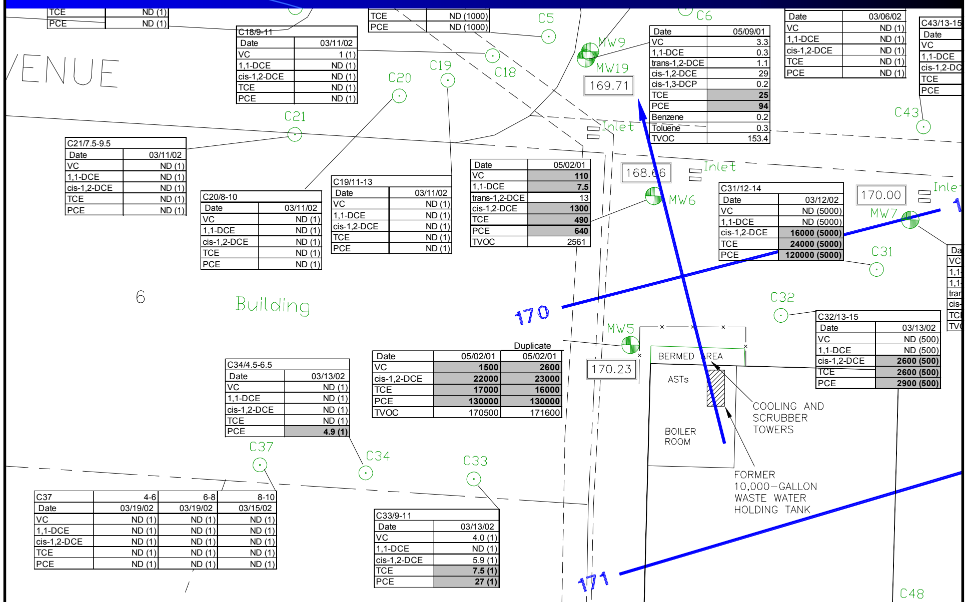
DRAI 30


GREEN BROOK
WASHINGTON AVENUE
Building
7
6
3
4
2
1.01
FAIRFIELD AVENUE
PASSAIC AVENUE

DRAI


GREEN BROOK
DRAINAGE EASEMENT
Building
3

DRAI



VENUE
TCE ND (1)
PCE ND (1)
C18/9-11
Date 03/11/02
VC 1 (1)
1,1-DCE ND (1)
cis-1,2-DCE ND (1)
TCE ND (1)
PCE ND (1)
TCE ND (1000)
PCE ND (1000)
C5
C6
MW9
MW19
169.71
C20
C19
C18
C21
Date 05/09/01
VC 3.3
1,1-DCE 0.3
trans-1,2-DCE 1.1
cis-1,2-DCE 29
cis-1,3-DCP 0.2
TCE 25
PCE 94
Benzene 0.2
Toluene 0.3
TVOC 153.4
Date 03/06/02
VC ND (1)
1,1-DCE ND (1)
cis-1,2-DCE ND (1)
TCE ND (1)
PCE ND (1)
C43/13-15
C43
Inlet
C21/7.5-9.5
Date 03/11/02
VC ND (1)
1,1-DCE ND (1)
cis-1,2-DCE ND (1)
TCE ND (1)
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C20/8-10
Date 03/11/02
VC ND (1)
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PCE ND (1)
C19/11-13
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cis-1,2-DCE ND (1)
TCE ND (1)
PCE ND (1)
Date 05/02/01
VC 110
1,1-DCE 7.5
trans-1,2-DCE 13
cis-1,2-DCE 1300
TCE 490
PCE 640
TVOC 2561
168.66
MW6
C31/12-14
Date 03/12/02
VC ND (5000)
1,1-DCE ND (5000)
cis-1,2-DCE 16000 (5000)
TCE 24000 (5000)
PCE 120000 (5000)
170.00
MW7
C31
6
Building
170
C32
MW5
Duplicate
Date 05/02/01 05/02/01
VC 1500 2600
cis-1,2-DCE 22000 23000
TCE 17000 16000
PCE 130000 130000
TVOC 170500 171600
170.23
BERMED AREA
ASTs
BOILER ROOM
C32/13-15
Date 03/13/02
VC ND (500)
1,1-DCE ND (500)
cis-1,2-DCE 2600 (500)
TCE 2600 (500)
PCE 2900 (500)
COOLING AND SCRUBBER TOWERS
C34/4.5-6.5
Date 03/13/02
VC ND (1)
1,1-DCE ND (1)
cis-1,2-DCE ND (1)
TCE ND (1)
PCE 4.9 (1)
C37
C34
C33
FORMER 10,000-GALLON WASTE WATER HOLDING TANK
C37 4-6 6-8 8-10
Date 03/19/02 03/19/02 03/15/02
VC ND (1) ND (1) ND (1)
1,1-DCE ND (1) ND (1) ND (1)
cis-1,2-DCE ND (1) ND (1) ND (1)
TCE ND (1) ND (1) ND (1)
PCE ND (1) ND (1) ND (1)
C33/9-11
Date 03/13/02
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1,1-DCE ND (1)
cis-1,2-DCE 5.9 (1)
TCE 7.5 (1)
PCE 27 (1)
171
C48

DRAI

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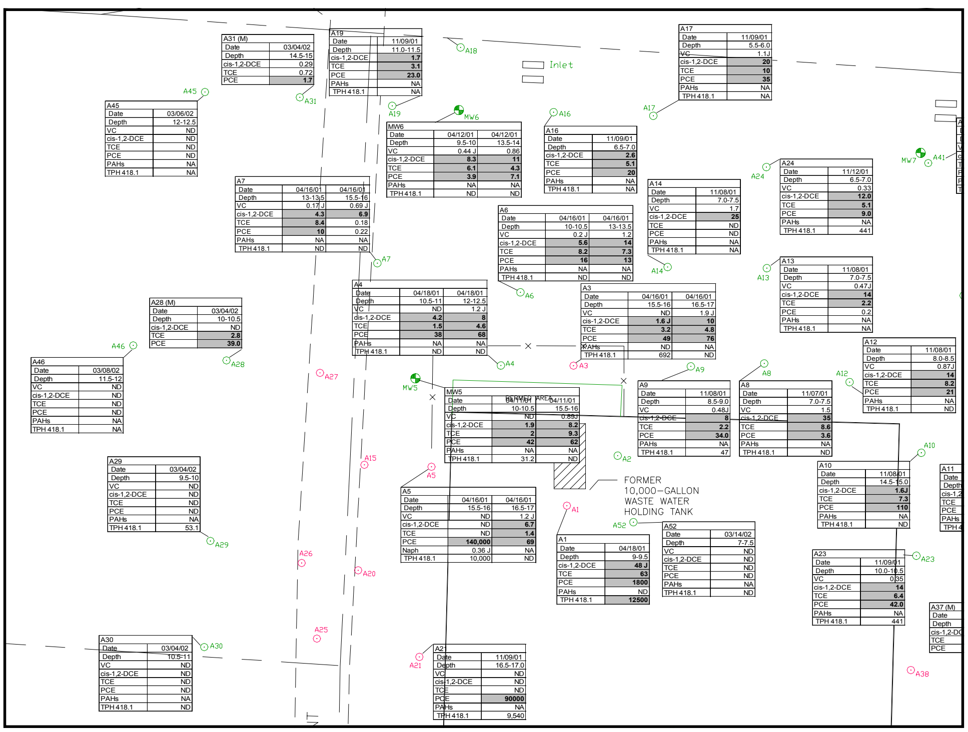

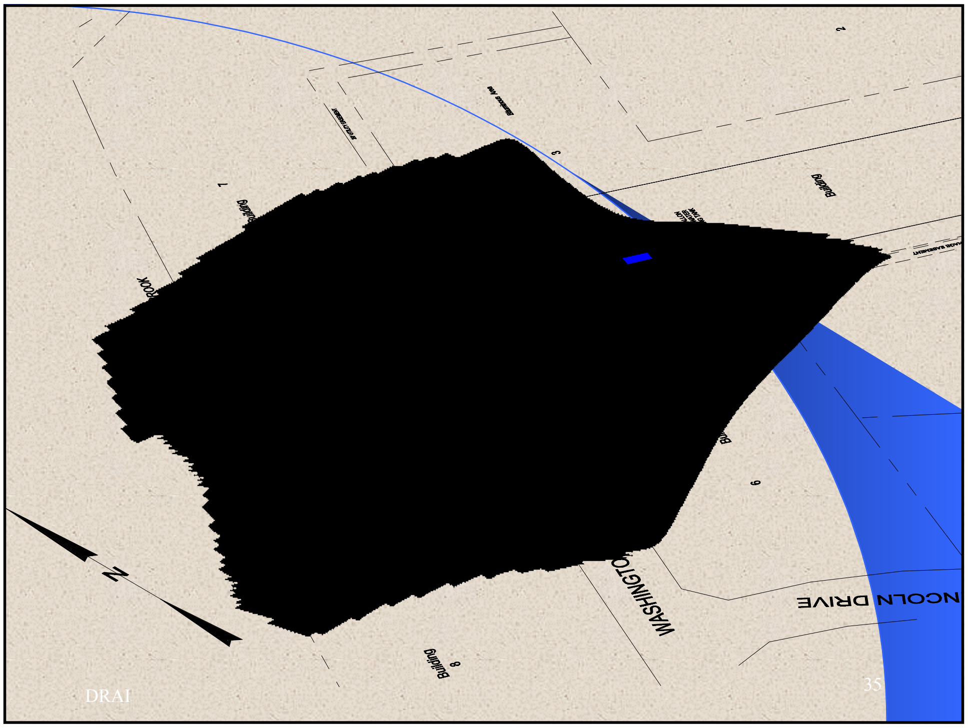

REMAINING RI TASKS

- Complete the vertical delineation by installing double cased wells into deep overburden zone
  - Could not be accomplished during delineation RI
- Pumping Test
  - No apparent benefit to conducting during delineation RI
- Surface Water Sampling
  - Green Brook, could have been conducted during delineation RI, Sediments were sampled

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TRIAD

Goal of cost-effective, defensible site decision making

- Systemic Planning
  - Conceptual Site Model
- Dynamic Work Plans
  - Streamlined Site Characterization
- On-site Analysis for Data Collection and Technical Decision-Making
  - Both for Screening and Definitive Purposes

Potential Obstacles

- Implementing Triad approach as envisioned by USEPA guidance at responsible party sites in NJ presents unique problems.
  - Tech Regs
  - Coordination with NJDEP case manager while in the field (case managers case loads may be to great)
  - Limited accountability of environmental consultant (Triad relies on professional judgement in the field, almost anyone can hang out a shingle in NJ)
  - Lack of mobile lab certification program

Obstacles

- "Smarter solutions may take two major forms. One is through new tools; the other is to revolutionize the strategy by which tools are deployed"
- "A conservative regulatory and engineering atmosphere strongly influences … site management to the point where even clearly demonstrated success is often powerless before difuss institutional, legal, and inertial forces that butress the status quo"
  - Source USEPA, Improving the Cost-Effectiveness of Hazardous Waste Site Characterization and Monitoring

LESSONS LEARNED

- Requires a higher level field geologist/project manager to be present at the site (staffing)
- **Develop a good Conceptual Site Model 1st**
  - PA/SI critical
- Coordination and understanding of mobile lab (New)
- Real Time communication with regulators
- Real Time communication with client (change orders)
- Coordination with driller (More than usual)
- Maximize sample collection each day

RESULTS

- Significant Site Characterization of a Complex DNAPL Site Completed Within 13 Days Approach required case manager to be available for consultataion during field work
- It could work if more autonomy given to consultant in the field
- Triad approach requires professional judgment not entirely consistent with current ways of doing things

DRAI 41

Thank You

DRAI 42

USE OF TRIAD APPROACH TO INVESTIGATE PROPERTIES IN ASSUNPINK CREEK GREENWAYS PROJECT

Jim Mack – New Jersey Institute of Technology
Todd Morgan- S2C2 Inc.

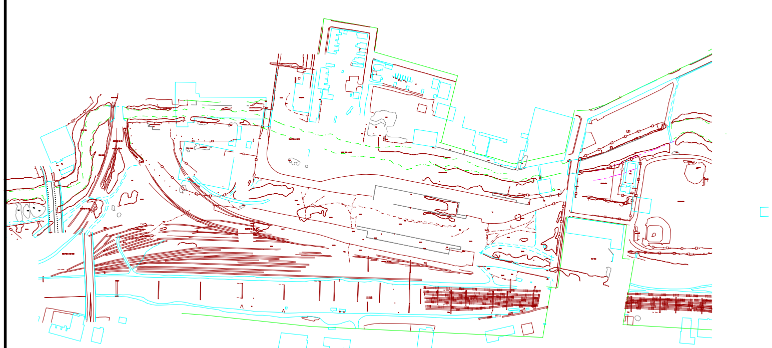
May 16, 2002

Cooperative Effort Among Many Stakeholders

- City of Trenton Dept. of Housing & Development
- New Jersey Institute of Technology- NHSRC Technical Assistance for Brownfields (TAB)
- Region II EPA
- EPA Technology Innovation Office
- New Jersey Dept. of Environmental Protection
- US Army Corps of Engineers- Philadelphia District

Background

- Approximately 45 ac. consisting of 11 parcels
- Assunpink Creek runs throughout study area
- Largest parcel is old freight yard
- Industrialized since late 1800's
- Limited historical information
- Highly urbanized area
- Redevelop into recreational park and greenway



Map of Greenways Project Area

Various View of Study Area Properties

Program Objectives

- **Characterize environmental impacts sufficient to allow development of remedial approach and costs**
- **Delineate horizontal and vertical extent of AOCs to Residential Direct Contact Soil Clean Up Standards**
- **Perform characterization as cost effectively and expeditiously as possible using Field Methods and Dynamic WPs to the fullest extent allowable**
- **Distinguish historic fill from site specific AOCs**

Planning: Conceptual Site Model

- Used to develop consensus among stakeholders
- Define important issues w/regard to project
  - historic fill distribution/contaminants
  - wide range of potential COCs (VOCs, TPH, PCBs, PAHs & metals)
  - multiple AOCs (drums, ASTs, discolored soil, rail yards, soil piles & discharge pipes)

Complex site conditions warrant innovative approach

Planning: Stakeholder Meetings

- **End use defined by Trenton**
- **Establish clean up "action levels"**
- **Identify project goals**
- **Identify key decisions needed to achieve goals**
  - historic fill distribution
  - number of AOCs requiring remediation
  - targeted COCs
- **Data quality requirements**
- **Communication procedures among stakeholders**
- **Define structure of investigation program**

Planning: Overall Approach

- Implement in two Phases
- Phase I designed to address critical issues associated with historic fill distribution, COCs and AOCs
- Phase II designed to address critical issues associated with AOC delineation and magnitude of remediation needed

Planning: Phase I

- Critical issues
  - historic fill distribution?
  - COCs in historic fill impact underlying soil?
  - potential AOCs: eliminate or further delineate?
  - targeted COCs
- Action levels: residential soil criteria
- DQOs require combination of FAMs, mobile laboratories & fixed base analysis

Phase I: Historic Fill

- Delineate distribution w/conductivity probe
- Verify w/select borings
- Real time read out allows in-field decision making
- Target unique strata in fill and fill/native soil interface
- Chose intervals for analysis after planning meeting
- Analysis combination of fixed base and field based

Conductivity Probe & Soil Comparison

Phase I: Historic Fill Findings

- Conductivity probe quick, inexpensive, efficient method
- Fill thickness and unique zones identified
- Native soil beneath fill not impacted
- Target sampling of unique zones in fill indicate PAHs & metals COCs
- Variability to fill material across project area

Phase I: AOC Evaluation

- Field observations & PA used to identify potential AOCs
- Different types- point source, spills, tank releases, area wide impacts, sediments
- Purpose to identify those requiring further delineation
- Use mix of FAMs, mobile labs and fixed base analysis

Phase I: AOCs Findings

- Predominant COCs: PAHs, PCBs, Metals, TPH
- Area wide impacts in Freight Yards
- Fuel spills in Freight Yards mixed w/area wide
- PCB sin one area at depth; requiring delineation
- High levels of PAHs & metals at point locations
- Sediments are impacted at point locations
- Some potential AOCs could be eliminated

Data Quality Management

- Three levels of analysis
- On-site analysis:
  1. FAMs; XRF (metals) & UVF (PAHs, TPH)
  2. Definitive noncertified methods (compound specific PAHs & TPH)
- Fixed Base Analysis
  3. Standard SW-846 methods for full range

Data Quality Management

- Semi qualitative
- High sample throughput
- Not compound specific
- Gross concentration estimates
- Backed up by mobile lab and fixed base
- In field delineation of AOCs mixed w/ area wide impacts

Field Methods- Ultraviolet Florescence & Nition XRF

Data Quality Management

- Definitive non certified
- Modified method 8270 (GC/MS)
    - a.PAHs, TPH, PCBs
    - b.24 hr tune, 24 hr calibrations, no MS/MSDs
- Experienced analysist
- Compound specific
- Lower reporting limits

Interior of Mobil Laboratory

Data Quality Management

- Collaborative analysis scheme
- High throughput FAMs yield sample density
- Definitive non certified provided in field performance checks
- SW-846 provides verification samples

Phase II: AOC Delineation

- RFP developed based upon Phase I work
- Phase I successfully focus next work
- Triad Approach will be used extensively
- Detailed delineation needed to develop information for end use planning
- Triad Approach allows greater sampling densities, particularly in large impacted areas in freight yard
- Objective to remove uncertainty regarding magnitude of remedial effort

Conclusion

- Systematic planning essential to effective program
- Large Brownfield sites are complex
- Triad Approach provides flexibility to adapt to complex site
- Integrated data management provides best of both worlds
- Detailed delineation needed for to remove cost uncertainty for municipal programs

Thank You

Managing Decision Uncertainty Using the Triad Approach

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May 16, 2002

Take-Home Message # 1

Using
SOUND SCIENCE
when evaluating contaminated sites means that the
the scale of data generation and interpretation
must closely "match"
the scale of project decisions being based on that data.

"Sound science" also requires managing uncertainty,
since an <u>exact</u> match usually is not feasible.

2

For example, if a decision must be made about whether a site poses a risk to ecological or human receptors, the interaction between the site specifics with the risk model being applied will determine the exposure pathways that must be evaluated, the spatial scale of the exposure units, and other specifics that will drive the number of site samples and the sampling strategy for needed for scientific defensibility. The interaction between site considerations and the risk model will determine what the analytes of concern are, whether chemical speciation and bioavailability should be considered, what quantitation limits will be needed, and other specifics that will drive the selection of the analytical methods and the performance of those methods.

In turn, this means that the scales of data generation and interpretation (i.e., data representativeness and uncertainty both on the sampling side and on the analytical side) must be explicitly matched to the scale of decision-making.

Potential scales include spatial (inches, yards, miles); temporal (minutes, days, years); chemical identity (target analyte, target + daughters, analyte class, surrogate marker). Uncertainty is always involved, and the scale of uncertainty in each aspect of the data generation and interpretation process must be also be matched to the scale that is acceptable in decision-making.

Make a provocative statement: The environmental data quality model accepted as status quo is inadequate to ensure that this matching occurs.

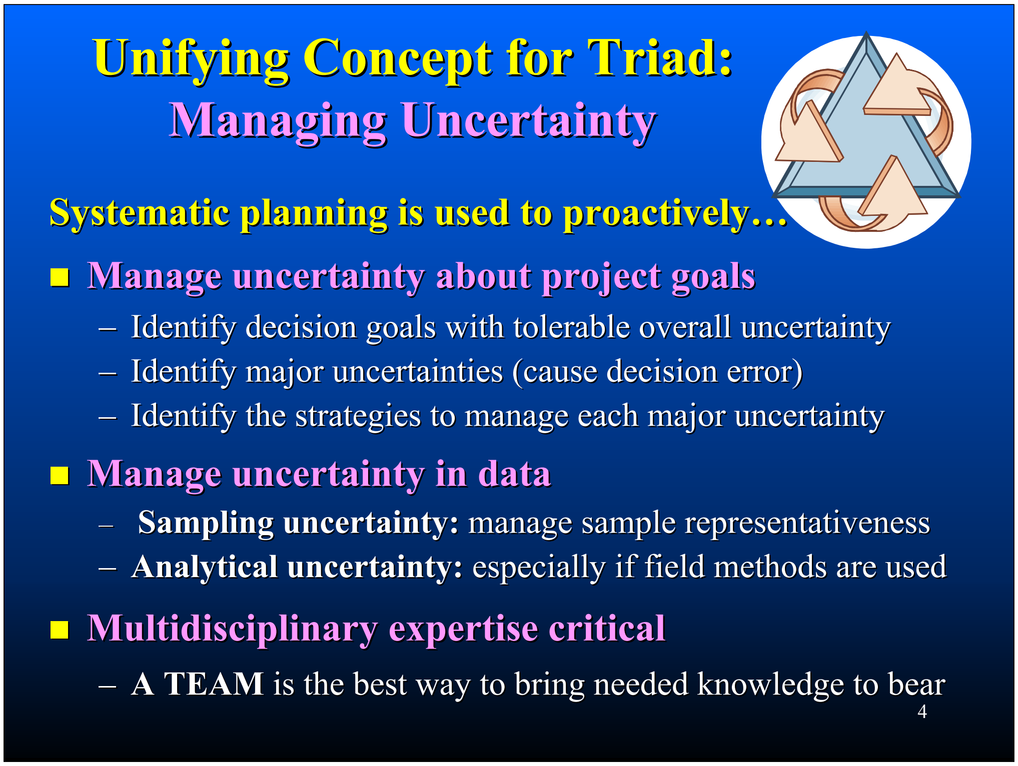
Managing uncertainty in data generation and in interpreting data requires expertise. "Sound science" cannot be conducted without the inclusion of data generation and interpretation expertise.

Take-Home Message # 2

- The Triad Approach seeks to institutionalize uncertainty management through holistic integration of innovative data generation and interpretation tools
- **Triad Approach** = Integrates **systematic planning**, **dynamic work plans**, and **real-time analysis** as applied to wastes and contaminated sites to $\Downarrow$ time & costs and $\Uparrow$ decision certainty
- Theme for the Triad Approach = Explicitly identify and manage the largest sources of decision error, especially the sampling representativeness of data

3

The basic concepts of the Triad are not new. The Triad is a re-articulation and broadening of the original DQO concepts, just as the DQO process was an articulation of the scientific method customized for the environmental regulatory arena. The Triad adds emphasis, however, on "recognizing, identifying, and managing uncertainty" as the mechanism through which good science is practiced and defensible decisions are made within the environmental cleanup context. The Triad approach is being developed as the technical foundation for the next generation of site characterization and cleanup practice and as the technical underpinnings of the one-cleanup-program envisioned by OSWER upper management. The Triad approach was articulated to serve as a technically sound and internally consistent scientifically-based technical paradigm around which successful sampling, analytical, and remedial strategies could be integrated, while welcoming future innovations and cleanup program evolution.



Decision uncertainty: What decision errors are you willing to tolerate? To what degree are you willing to tolerate them?

The major uncertainties are those that can make you make decision errors that you are not willing to tolerate.

Dynamic Work Plans

- Real-time decision-making "in the field"
  - Evolve CSM in real-time
  - Implement pre-approved decision tree using senior staff
  - Contingency planning: most seamless activity flow possible to reach project goals in fewest mobilizations
- Real-time decisions need real-time data
  - Use off-site lab w/ short turnaround?
    - » Use screening analytical methods in fixed lab?
  - Use on-site analysis?
    - » Use mobile lab with conventional equipment?
    - » Use portable kits & instruments?

Mix And Match

In all cases, must generate data of <u>known</u> quality

Dynamic work plans

•Real-time, decision-making "in the field" allows for a more seamless flow of site activities = fewer mobilizations

•Regulator-approved decision trees guide data gathering to support evolving the CSM to maturity

•A senior staff member is usually on-site to make decisions; but other key staff need not be on-site to participate in real-time. With computer software, Internet hookups, fax and cell phone capability, real-time information-sharing between senior staff, regulators, or technical experts no longer depends on ALL being physically in the field at the time of decision-making.

On-site Analyses

•Produce real-time data

•Support implementation of dynamic work plans

•Permit management of sampling uncertainty

•Method/technology selection and QC design based on integrating the intended data uses with available technologies that can meet the turn-around time and "field-friendliness" needed to support the dynamic work plan.

•Mix-and-match methods according to specific needs (e.g., field and traditional lab methods; direct push in situ detections and an on-site lab; etc.)

Generating Real-time Data Using Field Methods

Manage Uncertainty through Systematic Planning

- **Need clearly defined data uses—tie to project goals**
- **Understand dynamic work plan—branch points & work flow**
- **Project-specific QA/QC protocols matched to intended data use**
- **Select field analytical technologies to**
  - Support the dynamic work plan (greatest source of $$ savings)
  - Manage sampling uncertainty (improves decision quality)
- **Select fixed lab methods (as needed) to**
  - Manage uncertainties in field data (just ONE aspect of QC for field data)
  - Supply analyte-specific data and/or lower quantitation limits (as needed for regulatory compliance, risk assessment, etc.)

6

Clearly defined project goals include

- Preferred and alternative reuses for the site, and the rigor of evidence needed to support closeout under each option.
- Risk drivers, exposure pathways, etc. that need to be considered under each option.
- Budgetary, regulatory, legal, stakeholder and other constraints that will affect the feasibility of each reuse option.

Develop the dynamic work plan to include strategies that anticipate and manage sources of uncertainty that could potential impact decision quality. Draw as much as possible on historical or pre-existing information and data as a means to manage some of the uncertainty about nature and extent of contamination. Focus data collection to fill remaining gaps and/or minimize unacceptable uncertainty in projections developed from evaluation of pre-existing information.

Select field analytical technologies to

- Support the DWP strategy (coordinate sample throughput rates; provide information critical to making choices at the branch points in the decision tree)
- Manage sampling uncertainty by
  - Increasing sampling density to characterize heterogeneity
  - Adaptive sampling to delineate hot spots and guide removals, as appropriate
  - Meet analytical goals to the degree possible given method capabilities

Select fixed lab methods to

- Manage uncertainties in the field results (evaluate the effect of potential interferences, establish method comparability with respect to project decisions or action/decision levels)
- Supply analyte-specific, low QL data as needed for regulatory compliance or risk assessment

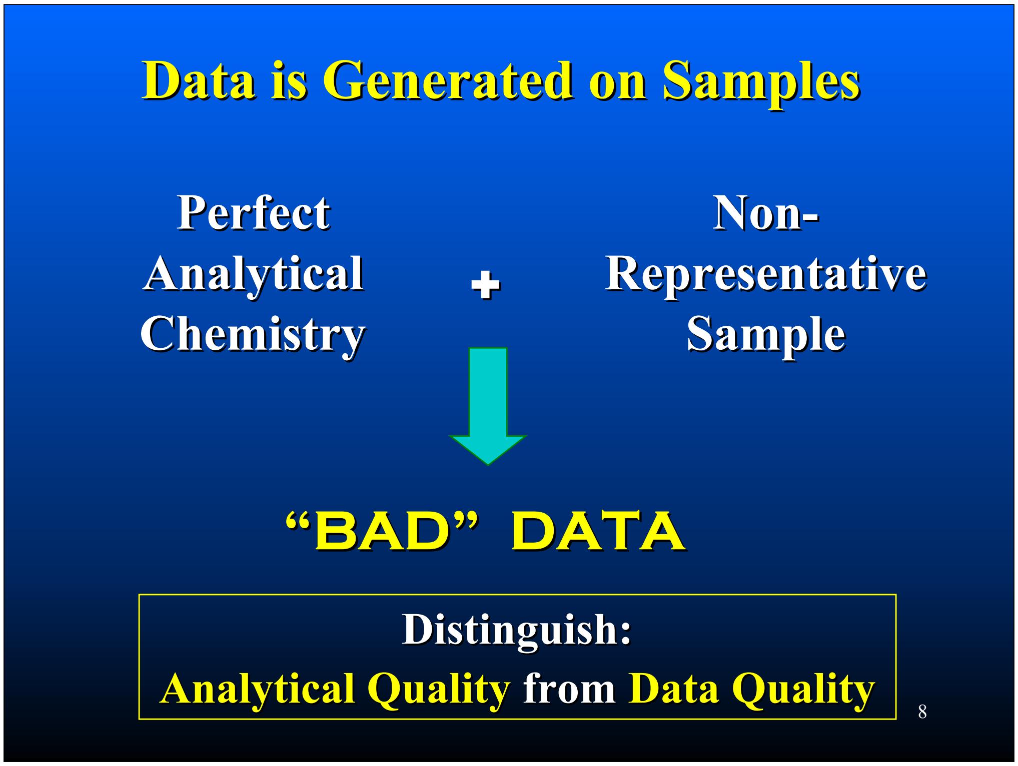
One of the reasons we hear most for why field analytical technologies aren't used more is that practitioners are not confident of the "data quality" generated by these methods. Follow-up to that issue usually elicits the response that project managers do not have ready access to analytical chemists experienced in the operation of field methods and in the interpretation of analytical data in the context of real-world environmental field projects. Why should this situation be tolerated in the environmental field?

One reason is the nearly universal view that environmental "data quality" can be guaranteed by using an "approved method." This view also holds laboratories solely responsible for ensuring "data quality." So it is not obvious to project and program managers that it is important to have a chemist involved in project-specific planning.

The following discussion explains

- why this view of data quality is incomplete;
- why environmental data quality cannot be achieved through one-size-fits-all approaches to sampling and analysis; and
- why a realistic view of data quality is vital to managing uncertainty and using the Triad approach properly.

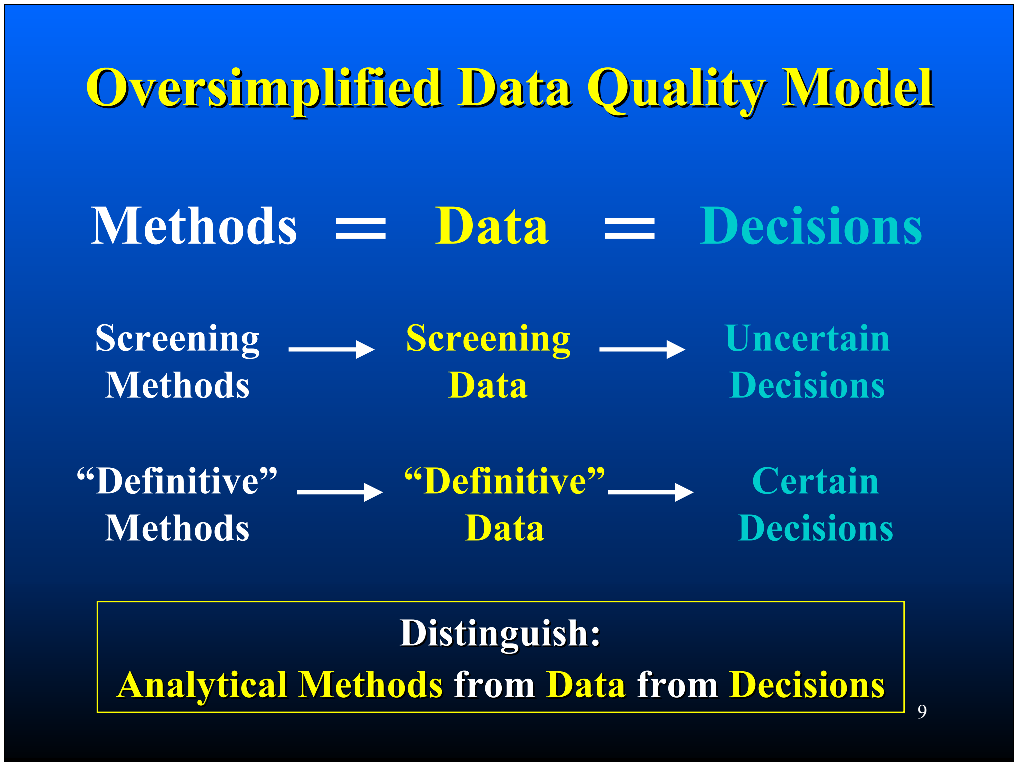
It is hoped that it should be obvious that public policy that strives for "sound science" in site cleanups should encourage creating and accessing pools of chemistry (as well as other technical, scientific, and statistical) expertise to be tapped as part of the multidisciplinary teams required to implement the Triad



You can have perfectly accurate analyses, but if the sample itself was not representative of the feature under investigation, the outcome is BAD data. It is "bad data" because data generated on non-representative samples is often misleading (i.e., leading to erroneous conclusions.

The issue of sampling representativeness, and the challenges posed by heterogeneous environmental media have been discussed for years in many different forums. Analytical scientists understand this concept very well. But it is not understood by many others in the environmental field, including policy-makers, program managers, and project managers.

Unfortunately, by focusing so much energy on prescriptive analytical methods, there is the widespread misconception that "highly accurate analyses automatically produce accurate data." In addition, the terminology we have developed over the years has become ingrained with unspoken assumptions that reinforce this misconception.



How do our regulatory and engineering models for site cleanup view the generation of environmental data?

Definitive analytical methods automatically produce definitive quality data.

Screening analytical methods automatically produce screening quality data.

Is this true? Well, first I propose we define our terms.

What is the difference between a definitive analytical method and a screening analytical method?

•The key is a difference in the perceived amount of uncertainty in analyte ID or in analyte quantification. Screening methods have (or are perceived to have) more uncertainty in one or both tasks than definitive methods.

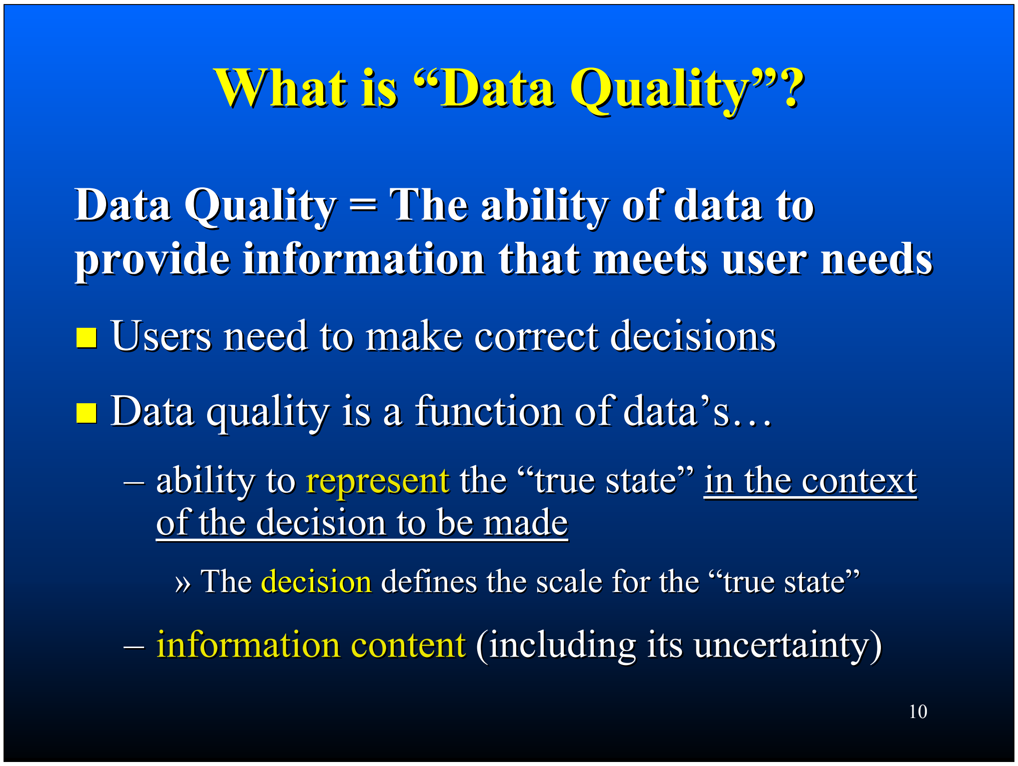
What is the difference between definitive data and screening data?

•The goal of generating data is to support making a decision. Therefore, definitive data are seen as supporting a defensible decision; whereas screening data are not, at least, not by themselves. So you could say that the difference between definitive data and screening data is the amount of uncertainty in the data set with respect to the decision to be made.

The common thread in contrasting the word "definitive" vs. the word "screening" is the degree of uncertainty in whatever we are talking about.

What is a "method"?

•An analytical method is the general description of the procedures used to operate an analytical technique. For example, GC-MS is a technique that can be used to detect and quantify chemicals that have properties that allow them to be volatilized in a gas stream through the GC, and are of sufficient molecular mass to be detected by the MS. Usually, a method is developed that is generally applicable to certain groups of contaminants. So there is a method for more volatile compounds (with boiling points less than about 200 C) and a different method for less volatile compounds (with boiling points



First of all, define key terms:

"Data" = analytical results for chemical contaminants generated on environmental samples that are used for supporting environmental decisions.

Quality = "the totality of *features* and *characteristics* of a product or service that bear on its ability to meet the stated or implied needs and expectations of the user" (USEPA OEI QMP 2000, v. 1.3) = "fitness for use" (Jeff Worthington, USEPA OEI, "Information Quality Systems" presentation at the May 2001 EPA Conference on Environmental Statistics and Information)

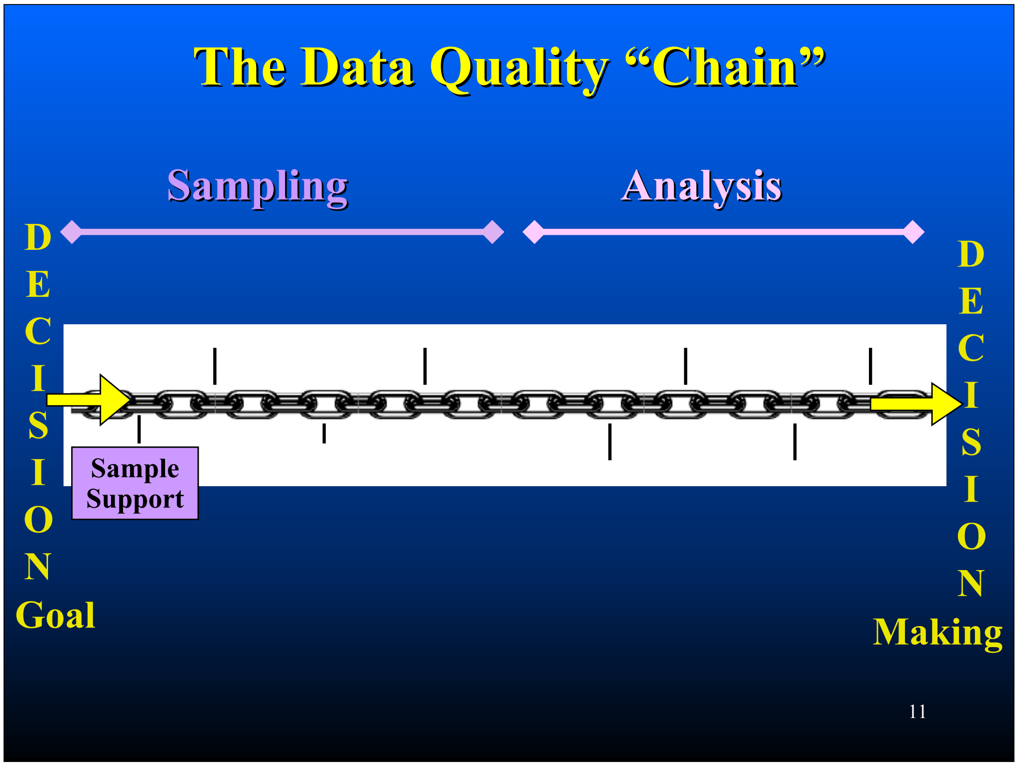
Data quality = "the totality of features and characteristics of data that bear on its ability to meet the stated or implied needs and expectations of the user/customer" (USEPA OEI QMP 2000, v. 1.3).

Data quality = "degree to which data satisfies stated or implied needs"… "High quality data is sufficiently trustworthy to meet the needs of the business purpose for which it was intended." (Oracle Data Quality Inspector software literature)

"…data quality, as a concept, is meaningful only when it relates to the intended use of the data. Data quality does not exist in a vacuum; one must know in what context a data set is to be used in order to establish a relevant yardstick for judging whether or not the data set is adequate." (USEPA QA/G-9; July 2000 version, page 0-1).

"Quality" is an emergent property arising from the interaction of several characteristics of the element in question (such as "data," as in data quality, or "information," as in "information quality") with various aspects of the intended use of that element (i.e., how the data or information are to be used). For that reason, terms involving "quality" (data quality, water quality, air quality, etc.) have always been very broad and ambiguous. If "quality" is "good," the implication is that all characteristics of that element are in line with the intended use. If "quality" is "poor," additional explanation is needed to know which characteristic(s) is(are) not synchronized with the intended use. For example, "poor water quality" could be due to high levels of bacteria or nutrients or pollutants, or low dissolved oxygen or low pH, etc.,etc. More information is needed to understand the reason for the "poor quality."

It is also possible for identical values of the same characteristic to be considered "good quality" under one intended use scenario, yet constitute "poor quality" under a different intended use scenario. Therefore, any efforts to correct "quality" problems must become very specific about what

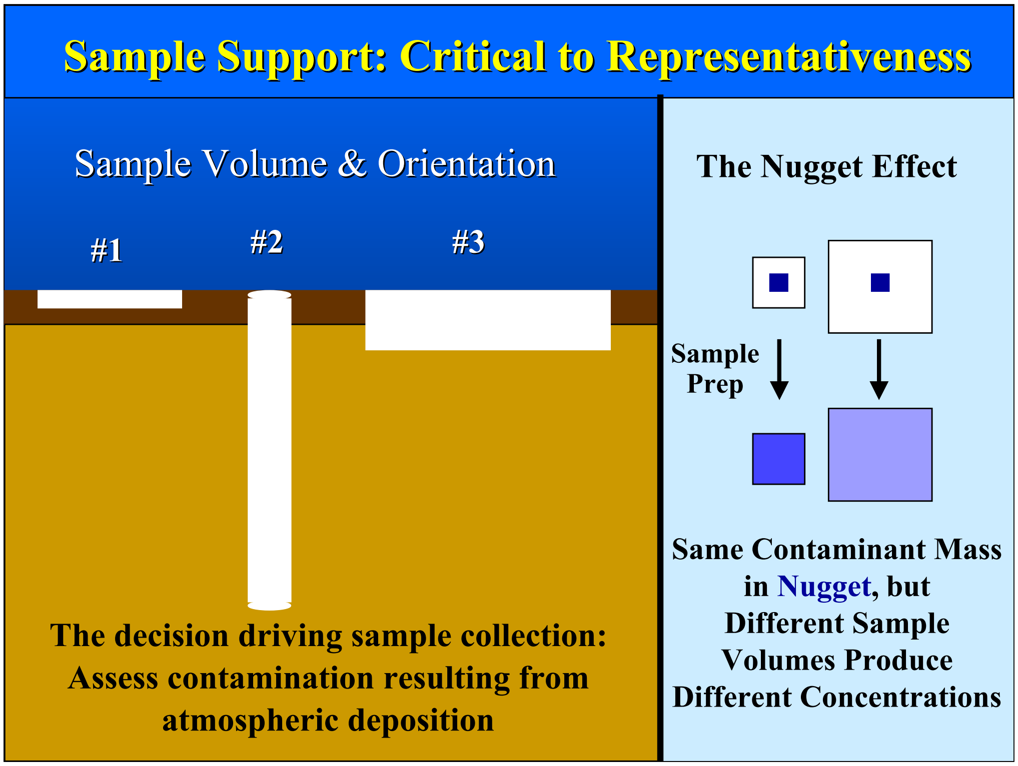


Various sources of uncertainty that impact "data quality."

Sample Selection must be representative of the site conditions in the context of the decision to be made. The representativeness of Sample Selection can be further broken into Sample Collection and Pre-analysis Sample Processing.

Sample Collection itself is composed of 2 components:

- Sample support = volume, dimensions, and physical orientation of the specimen being removed from the parent matrix. How should a sample/specimen be removed so that it retains the characteristics of the parent matrix that is under investigation? This is explained more clearly on the next slide.



This slide illustrates 2 concepts related to "sample support." These concepts are presented in a highly simplified form and do not cover the finer points of this topic.

The panel on the left illustrates how sample volume and orientation must be selected to be representative of the decision to be made. Any of the 3 samples might be argued to represent true site conditions, but only one can be argued to be representative of site conditions in the context of the decision (atmospheric deposition).

Color Key for left panel:

- Dark brown depicts surface soil impacted by surface deposition of lead from the atmosphere.
- Light brown depicts soil that would not be expected to be impacted by this atmospheric deposition.
- White areas depict the volume and orientation of material removed that becomes the "sample."

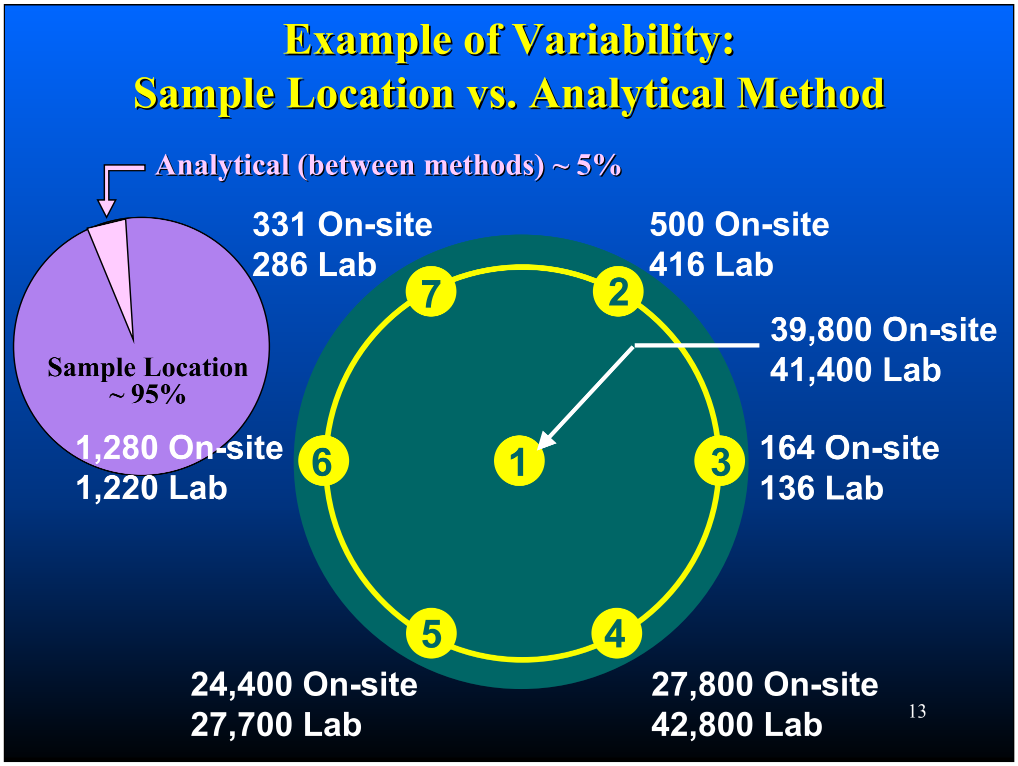
Keep in mind that the entire sample is homogenized prior to subsampling for analysis.

The sample support (the physical dimensions of the sample) for Sample #1 would be representative of the matrix impacted by atmospheric deposition, but the sample supports of samples #2 and #3 would not be. Sample support #3 illustrates the importance of strict control over sample support in scenarios where careful stratification of populations is required to avoid biasing results by including non-representative sample. Even though the general orientation of sample collection in #3 is similar to #1, the concentration of lead in sample #3 would be expected to be "diluted" by the inclusion of "cleaner" soil from a non-representative layer into the sample.

Right panel: The "nugget effect"

Color Key:

- Again, the white color represents cleaner sample matrix.



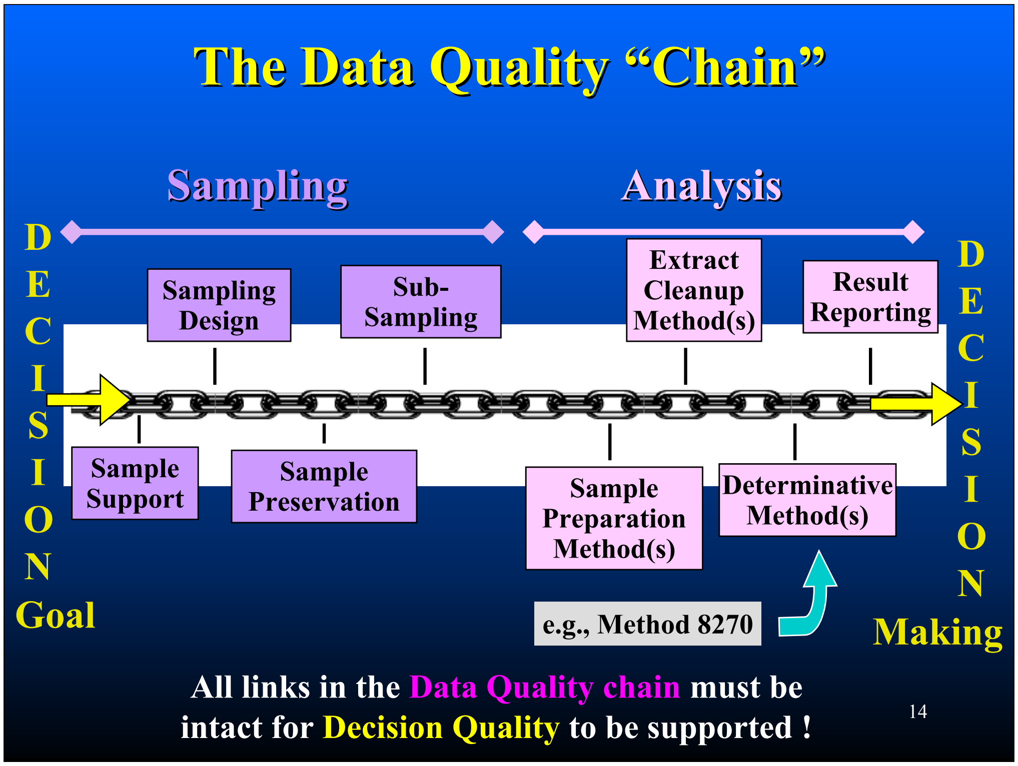
Example of characterizing sampling variability from USACE/CRREL work (Tom Jenkins) [see various reports at http://www.crrel.usace.army.mil/techpub/CRREL_Reports/html_files/Cat_X.html]. This example is from the Monite installation, which is contaminated with explosives residues (the facility reclaimed explosives from out-of-date munitions).

The wheel presented the results of the analysis of the set of 7 discrete samples. The analyte = TNT; units = ppm. Diameter of wheel = 122 cm (4 ft). Surface samples were taken from 0 cm to 15 cm depth (0 – 6 inches), by a stainless steel auger with diameter = 5 cm (2 inches).

Each soil core (one from each of the 7 locations) was thoroughly homogenized. Subsamples from the homogenized sample were analyzed by both an on-site analytical method (EnSys Colorimetric Test Kits; EPA SW-846 Method 8515) and in a traditional laboratory (EPA SW-846 HPLC Method 8330). Note the general agreement of the on-site colorimetric results with the off-site HPLC results. Note the differences in the results among the seven sampling locations. A very different decision regarding the need for remediation might be made if the location for sample collection was at position number 1 or position number 7 (although they are only 2 ft apart)!

An analysis of variance (ANOVA) partitioned the variability in results between 1) the variability due to the position of the sample (sample location) and 2) differences between the field vs. lab analyses. It found that 95% of the total variability was due to position (that is, due to matrix heterogeneity) and only 5% was due to the difference between analytical method. Another way to state this is that: In this example, matrix heterogeneity caused 19 times more uncertainty in the data results than did the choice of analytical method, over a distance of only about 2 feet.

Conclusion: Spatially, the matrix was very heterogeneous with respect to its concentration of TNT and since any one of these discrete samples would be a legitimate sample by the traditional approach, the traditional approach would not provide representative samples to characterize this site.



Various sources of uncertainty that impact "data quality," continued.

Sample Selection must be representative of the site conditions in the context of the decision to be made. The representativeness of Sample Selection can be further broken into Sample Collection and Pre-analysis Sample Processing.

Sample Collection itself is composed of 2 components:

•Sample support = volume, dimensions, and physical orientation of the specimen being removed from the parent matrix. How should a sample/specimen be removed so that it retains the characteristics of the parent matrix that is under investigation?

•Sampling design = sample numbers, locations, and timing. How many, where, and when should samples be collected so that the data set will give an accurate representation of the question being asked about a site?

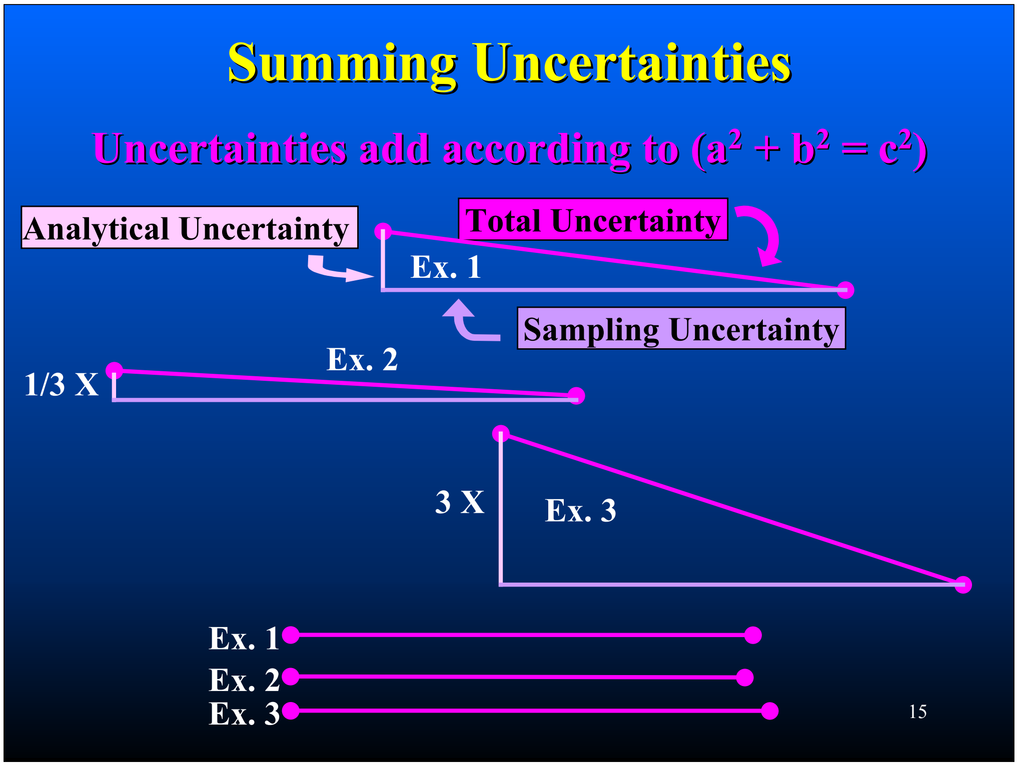
Pre-analysis Sample Processing consists of sample preservation (if required) and transport to the analytical facility. Once in the analytical facility, the bulk sample is usually subsampled to take an aliquot that will be further processed for the actual analysis. Significant loss of sample integrity (and erosion of sample representativeness) can occur during both sample transport and subsampling.

•Sample preservation between collection and analysis = Are the analytes that were originally present in the sample when it was part of the parent matrix still present in the same concentrations by the time the sample is prepared for analysis?

•Sample subsampling for analysis = Will the subsample actually subjected to analysis accurately reflect the properties of the bulk sample?

Sample Analysis must also be representative of the site conditions in the context of the decision to be made. Sample Analysis is composed of several components:

•Sample preparation method(s) (drying, grinding, heating, purging, extraction with solvent, digestion with acid) = Will the sample preparation step accurately transfer the target analytes into a form that can be introduced into the determinative method? Or could losses



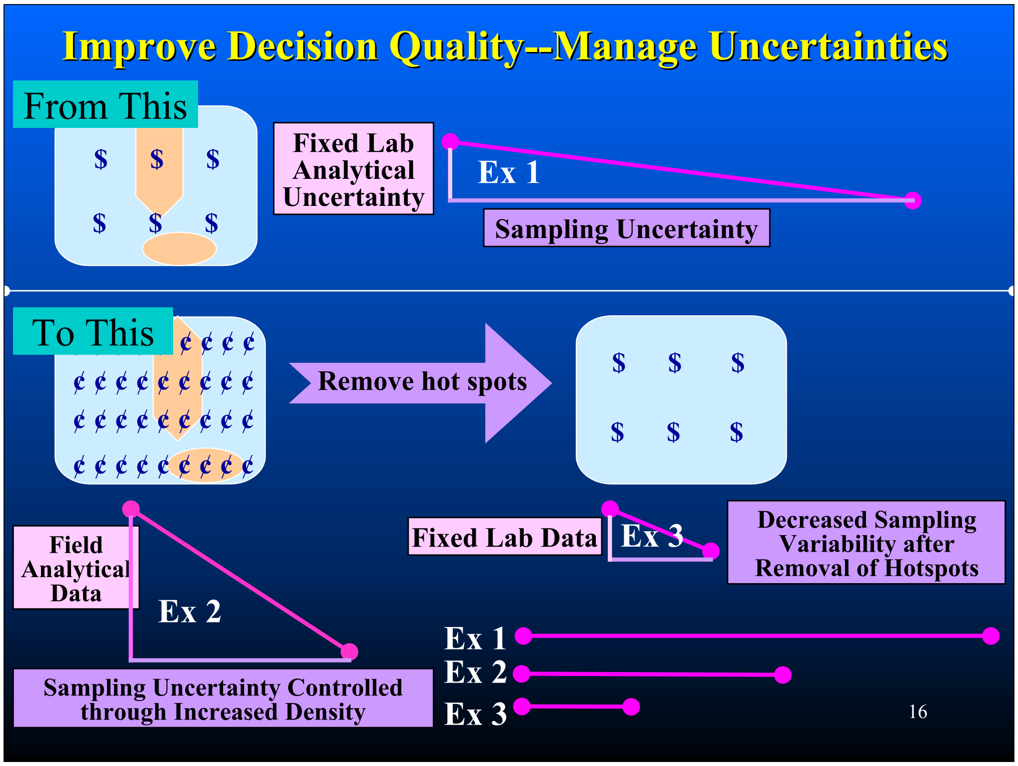
Helping policy-makers to understand the importance of managing sampling uncertainty. (Although presenting uncertainty this way oversimplifies the mathematics involved to compress the individual sources of uncertainty into only 2 major components, this legitimately illustrates the basic concept.)

Uncertainties (when expressed as statistical standard deviations) add as orthogonal vectors, that is, the sum of 2 uncertainty components (represented by the sides of a right triangle) is represented by the hypotenuse. The heterogeneity of environmental materials, especially solids (waste materials, soils, the subsurface) is very high. The vast majority of result uncertainty in environmental samples is due to sampling considerations. Attempts to quantify the relative contributions of sampling and analytical variabilities to the environmental measurement process have "estimated that up to 90 percent of all environmental measurement variability can be attributed to the sampling process." (Reference: Homsher et al, 1991, see Environmental Lab articles in Resources/Links section). It is reasonable to expect that the actual value would vary greatly from project to project and analyte to analyte, depending upon the environmental matrix and the concentrations of the contaminants, the mechanism by which contaminants were introduced into the environment, the fate and transport of the contaminants, as well as how the partitioning of variability was derived and calculated.

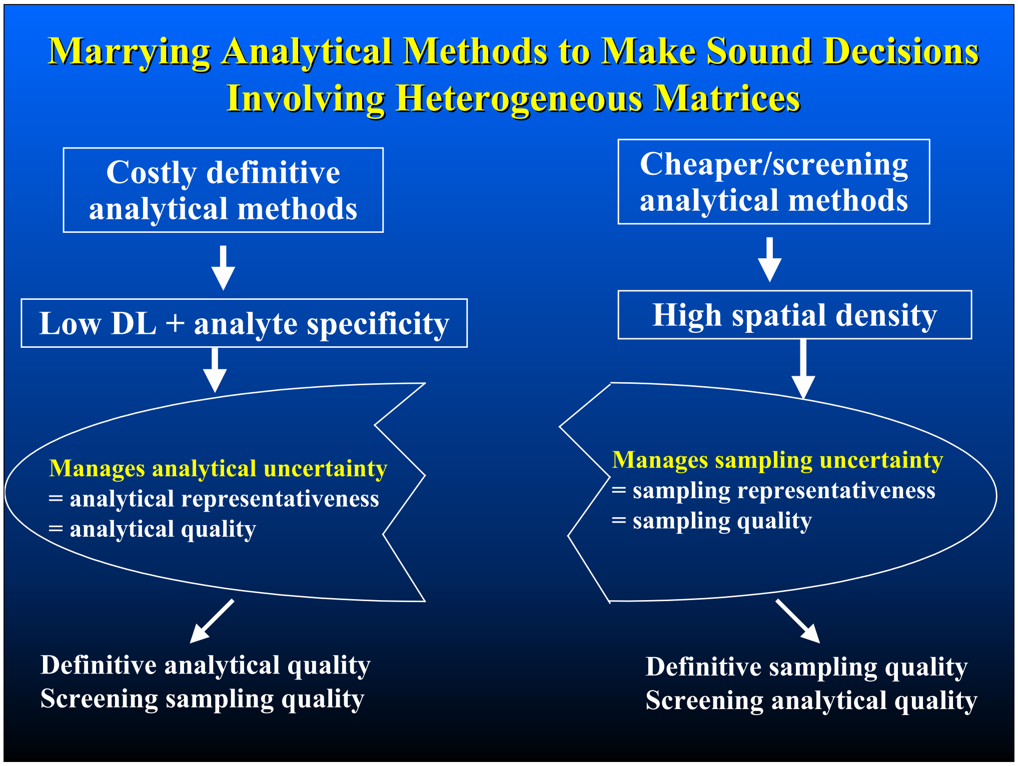
The Example 1 figure illustrates a ratio of sampling uncertainty to analytical uncertainty in soil of about 9 to 1 ratio. As illustrated in Example 2, decreasing the analytical uncertainty to 1/3rd of the original without addressing sampling uncertainty will no doubt add to the analytical costs, but will not meaningfully decrease the overall uncertainty in the data. Alternatively, allowing the analytical uncertainty to increase to 3 times the original without changing the sampling uncertainty does not significantly increase the overall uncertainty in the data (Example 3).

The overall uncertainty is what impacts the decision-making process (i.e., the overall data quality impacts the decision quality). Therefore, both analytical and sampling uncertainties must be managed. Minimizing one without addressing the other is pointless.

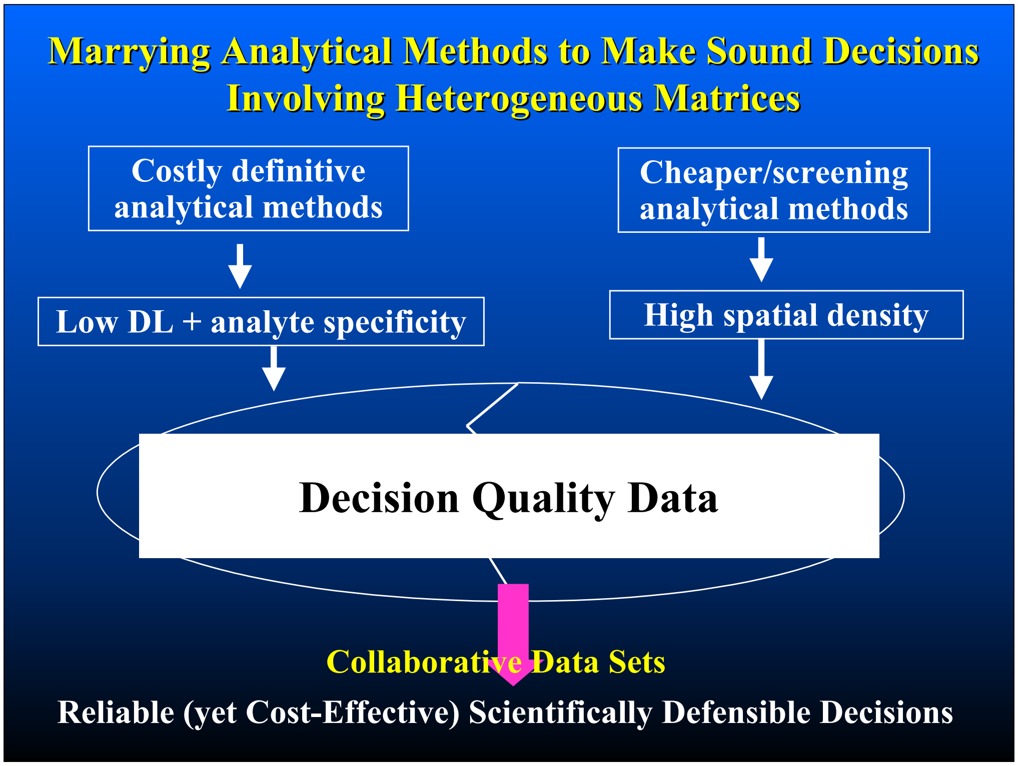
The Example 1 figure illustrates a ratio of sampling uncertainty to analytical uncertainty in soil of about 9 to 1 ratio. The selection of this ratio was rather arbitrary, largely to accommodate the



In contrast to the way definitive methods are conventionally used (upper panel), field analytical methods can be used to increase the sampling density, which permits rigorous management of sampling uncertainty (middle panel). Reliable site decisions can be then be made (such as whether to rigorously delineate and remove hotspots of contamination). If needed to meet regulatory requirements for final site closure, follow-on analysis of samples can be performed by definitive, analyte-specific methods. The selection of samples for final closure decisions builds on the previous characterization decisions or cleanup actions to markedly decrease sampling variability in the data set used to support site closure or decisions about regulatory compliance.

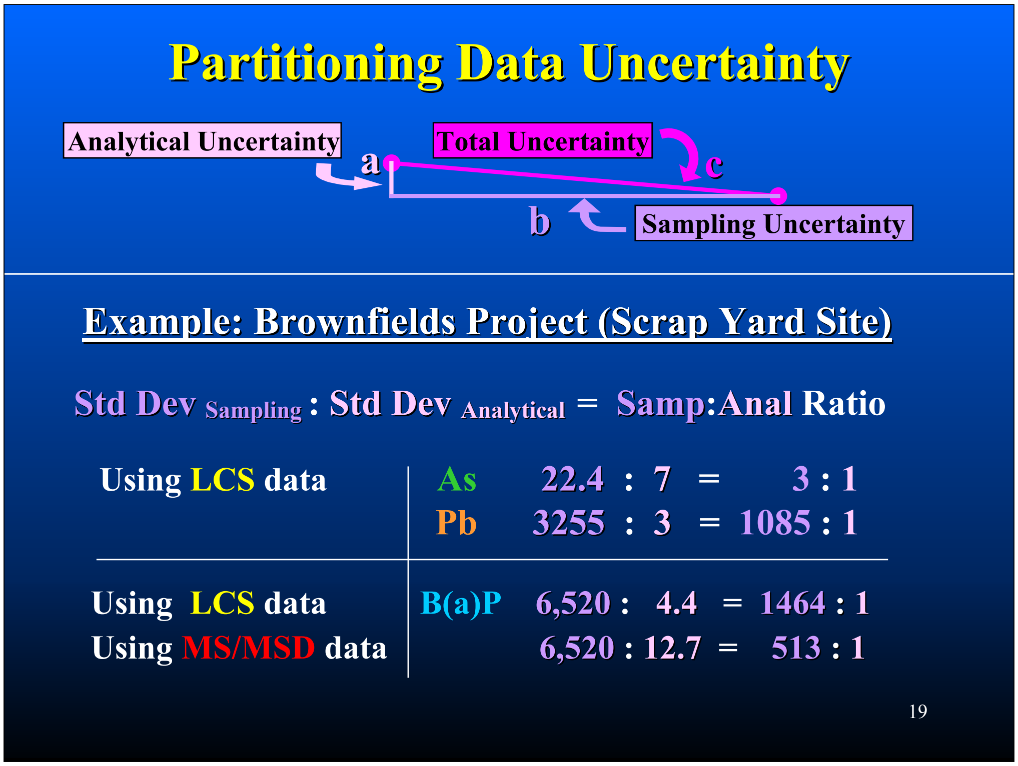


<u>Good data quality at an affordable cost</u> is generated by using both screening and more definitive methods in conjunction with each other. Because of their lower cost, screening methods are best for generating higher data densities that can manage for uncertainty due to environmental heterogeneity (sampling variability). Representative samples can then be selected for more rigorous analysis as needed to manage for remaining analytical uncertainty.



Collaborative data sets complement each other in that uncertainty in one data set is managed by the information in the other. The data sets must be used together to manage all major sources of potential error in the data sets. This is similar to a “weight of evidence” approach.

High density sampling is performed by using cheaper methods (which may be run in the field, although don’t have to be). The cheaper methods are often screening methods, but they may be definitive analytical methods (such as field-portable GC-MS for VOCs). After sampling uncertainty is managed, any residual analytical uncertainty needed to meet the desired decision certainty is managed using more rigorous methods (which may be run in a fixed lab, but don’t have to be). If there is no residual analytical uncertainty after sampling uncertainty is managed, no more analyses are required, and the second column is not needed. It depends on the nature of the method, the performance of the method with the site-specific matrix, and the nature of the decision to be made on the basis of the data.



The ratio of "sampling" vs. "analytical" variability (expressed as a standard deviation) can be coarsely partitioned using the following procedure (or a variation therefore):

Analytical variability (as pure method variability) can be estimated from the precision of the laboratory control sample (LCS) or matrix spike/matrix spike duplicate results.

•An LCS should go through the same sample prep, cleanup, and determinative method as the real samples. The more similar the LCS matrix is to the real-world matrix under consideration, the more representative the estimate of analytical variability will be of the analytical variability for the real-world samples. Usually, LCS matrices are clean, well-defined, "ideal" matrices that behave well in the analytical system.

•Matrix spike/matrix spike duplicate (MS/MSD) pair precision provides an estimate of the analytical variability experienced when real-world matrix effects are factored in.

Example site: Former scrap yard with soils contaminated with metals and petroleum hydrocarbons.

See "Partitioning Data Variability using a Scrap Yard Site Example" for a more detailed discussion.

Sample Representativeness is Key!

Finally able to address **defensibly and affordably!**

- **Cheaper analytical technologies permit increased sample density.**
- **Real-time measurements support real-time decision-making.**
  - Rapid feedback for course correction → smarter sampling
  - New software for statistical/geostatistical decision support
    - » VSP software pkg FREE: http://dqo.pnl.gov/VSP/index.htm
    - » SADA software pkg FREE: http://www.tiem.utk.edu/~sada/
    - » FIELDS/SADA software: http://www.epa.gov/region5fields/static/pages/index.html
- **Focus on overall data uncertainty: analytical uncertainty is often a relatively small fraction.**

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Thanks to technologies that are relatively new to the environmental field, we can begin to address the problem of sample representativeness. One aspect of these technologies that allows management of sampling uncertainty is the ability to run many more samples because per test costs are lower. Another aspect is that many, although not all, of these technologies can be run in the field. This saves sample preservation, transportation, and storage costs. But most importantly, real-time testing results support real-time decision-making, which offers a whole host of benefits—that I do not have time to go into in this talk.

Certain field analytical technologies, such as field-portable GC/MS can be operated as definitively as any lab-based GC/MS. But many field technologies are truly based on screening analytical methods, such as immunoassays, cell receptor assays, or colorimetric kits. And immediately, that is where language problems begin to cause problems with acceptance—because I have used the word "screening."

But first we have to overcome many regulatory and perceptual obstacles that limit acceptance of the new technologies. Many of these obstacles are built into the language that we use. What I want to do is make you aware of the conceptual traps in our terminology, so we can start using language that avoids ambiguity--that leaves no room for misconceptions.

Case Study: Wenatchee Tree Fruit Site

- Pesticide IA kits guide dynamic work plan: remove and segregate contaminated soil for disposal

230 **IA analyses** (w/ thorough QC) + 29 **fixed-lab** samples for 33 analytes

Managed **sampling uncertainty**: achieved very high confidence that all contamination above action levels was located and removed

Managed **field analytical uncertainty** as additional QC on critical samples: confirmed & perfected field kit action levels)

- Clean closure data set
  - 33 fixed lab samples for analyte-specific pesticide analysis
  - Demonstrate full compliance with all regulatory requirements for all 33 pesticide analytes to >95% statistical confidence the first time!
- Projected cost: ~$1.2M; Actual: $589K (Save ~ 50%)
- Field work completed: <4 months; single mobilization

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http://cluin.org/char1_edu.cfm#site_char

The key features of the project that contributed to its success included:

•Systematic planning accomplished by a team representing the USACE, EPA, the site owners, and state regulators with the appropriate mix of skills and decision-making authority.

•An initial conceptual site model based on a review of historical records from the site. The CSM is refined over the course of the project.

•A dynamic work plan that permitted the field team to make real-time decisions on the basis of data generated in the field.

•A pilot study demonstrated the utility of the field analyses and provided information used to establish site-specific action levels.

•An adaptive sampling and remediation strategy that relied on a combination of field analyses and fixed laboratory data.

The combined benefits of this approach facilitated the "surgical" removal and segregation of contaminated materials and ensured that closure testing would demonstrate regulatory compliance to a high degree of certainty. Significant time and cost savings over the life of the project were possible by making field activities such as sample collection, sample analysis, soil removal, soil segregation, and final disposal of soil and wastewater highly efficient and effective.

The case study report and supporting materials (USACE work plans) can be found at http://cluin.org/char1_edu.cfm#site_char (See entry for "Pesticide Site Cleanup Using a Dynamic Work Plan and Immunoassays")

Terminology to Integrate Data Quality into Decision Quality

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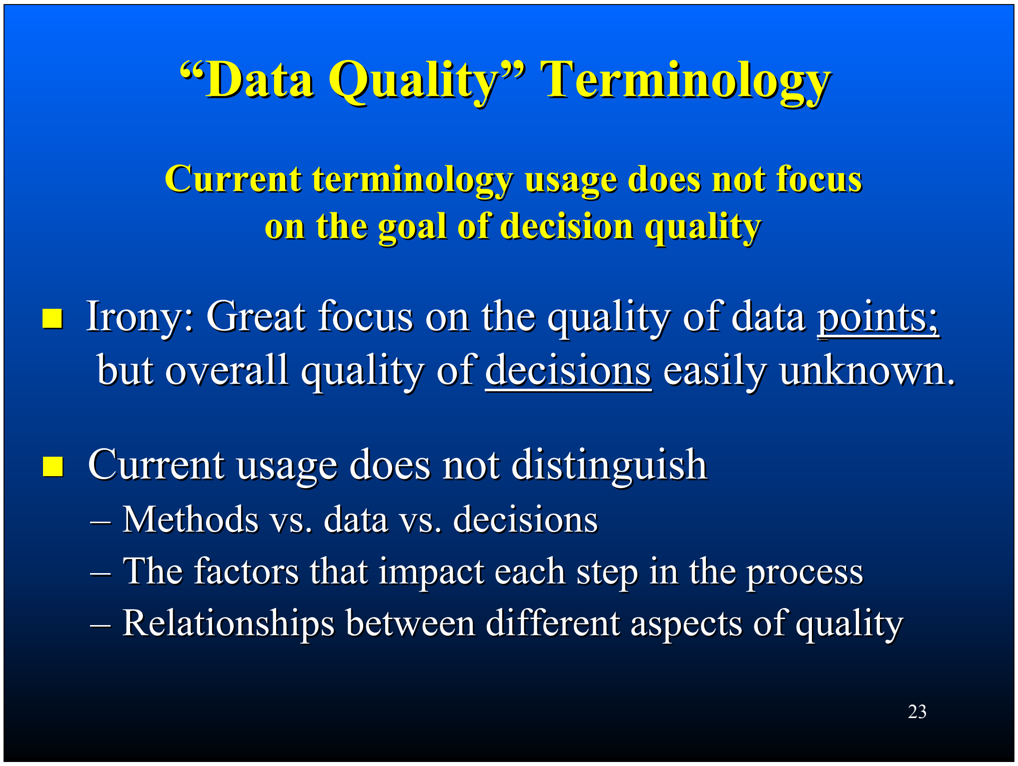
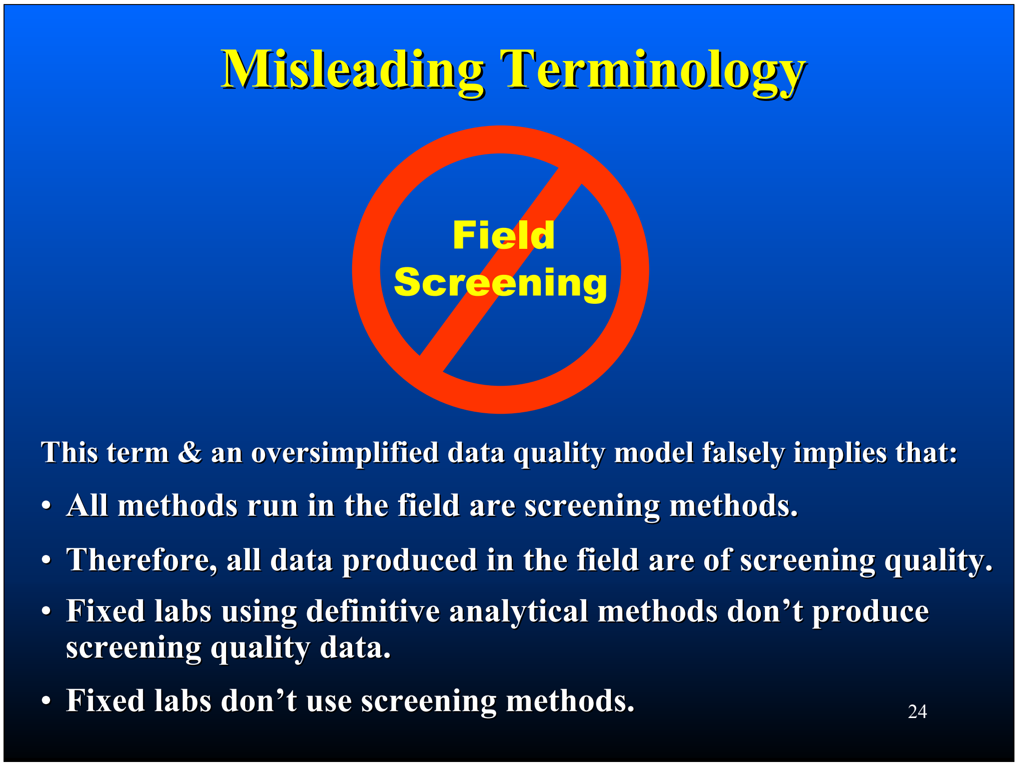


The current environmental “data quality” paradigm equates decision quality with analytical data quality, which is, in turn, equated with the nature of the analytical method. Therefore, it is a pervasive working assumption that definitive methods produce definitive data, and screening methods produce screening data. It is further assumed that analytical data quality (and thus decision quality, since they are not distinguished) for environmental samples can be achieved through generic prescriptive requirements on analytical methods. These assumptions have become embedded in “data quality” language in the environmental field. However, these assumptions are false, and they limit the ability to use innovative strategies and technologies, such as field analytical methods, which can actually improve decision quality.

Ironically, because of the large uncertainty in sample representativeness when a few samples are run for “high (analytical) quality” fixed lab analysis, true confidence in the overall decision may constitute “screening quality.” On the other hand, rigorous use of screening analytical methods to create a data set of high sampling density can produce more “definitive” decision quality. (“Rigorous” means that the analytical uncertainty is known and managed through a well-designed QA/QC program.)



The term "field screening" is discouraged because it is ambiguous. It also carries a number of implications that are not untrue (see the slide). The truth of the current technology situation is that:

•Definitive methods can be run in the field, and some field technologies are based on definitive methods (such as a field-portable GC-MS).

•Even when screening methods are used, the data may be completely capable of supporting defensible decisions. This is the antithesis of "screening quality data," which indicates there is too much uncertainty to support defensible project decision-making.

•Note that data produced by fixed labs using definitive analytical methods may be of screening quality data if sampling uncertainty is not controlled, if generalized methods are used to report analytes that behave poorly in that generalized method, or if matrix interferences compromise method performance.

•The use of screening methods in fixed laboratories would be highly cost-effective means of increasing sampling density and selecting representative samples for follow-up analysis by more definitive methods. If a dynamic work plan is not being used, rapid turn-around of results would not be needed. However, close coordination with the laboratory to develop and implement an analytical decision tree would be required.

“Effective Data”
“Decision Quality Data”

Data of

known quality

that can be logically demonstrated to be

effective for making the specified decision

because both the

sampling and analytical uncertainties

are managed to the degree necessary to meet clearly

defined (and stated) decision confidence goals

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•The decision(s) that the data are to support must be clearly articulated!!

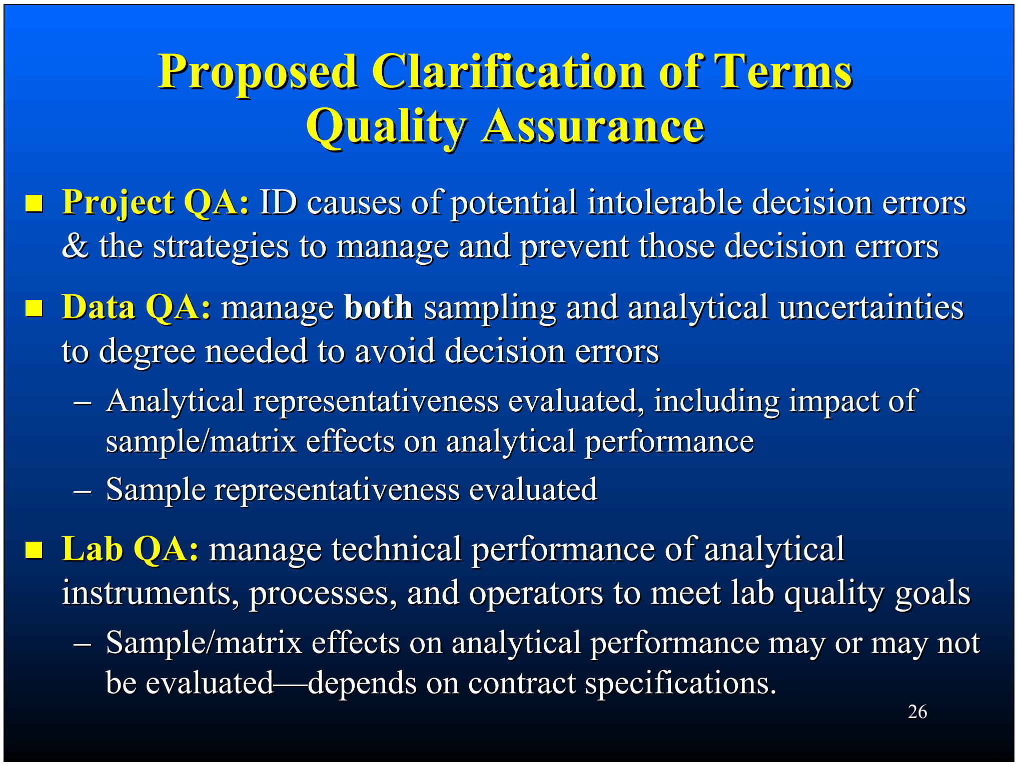
•Sample representativeness (location, timing, sample support, subsampling, sample integrity, etc.) must be explicitly considered in the context of the decision to be made.

•The impact of sampling variability must be balanced against the impact of analytical variability.

•Analytical uncertainties (analyte identification, sensitivity, variability in quantitation, the influence of interferences, etc.) must be acknowledged, understood, and managed to the degree needed to achieve the stated decision goals.

•Data of “known quality” means that adequate project-specific QC (QC that is relevant to addressing analytical uncertainties that bear on the decision) must be performed and documented.

If this chain of scientific evidence is not built (during planning, implementation, and data interpretation) you run the risk that decisions based on the data will be indefensible if challenged (even if the decisions were actually correct), or the decisions will be erroneous, resulting in wasted effort and expense or failure to protect receptors or both.

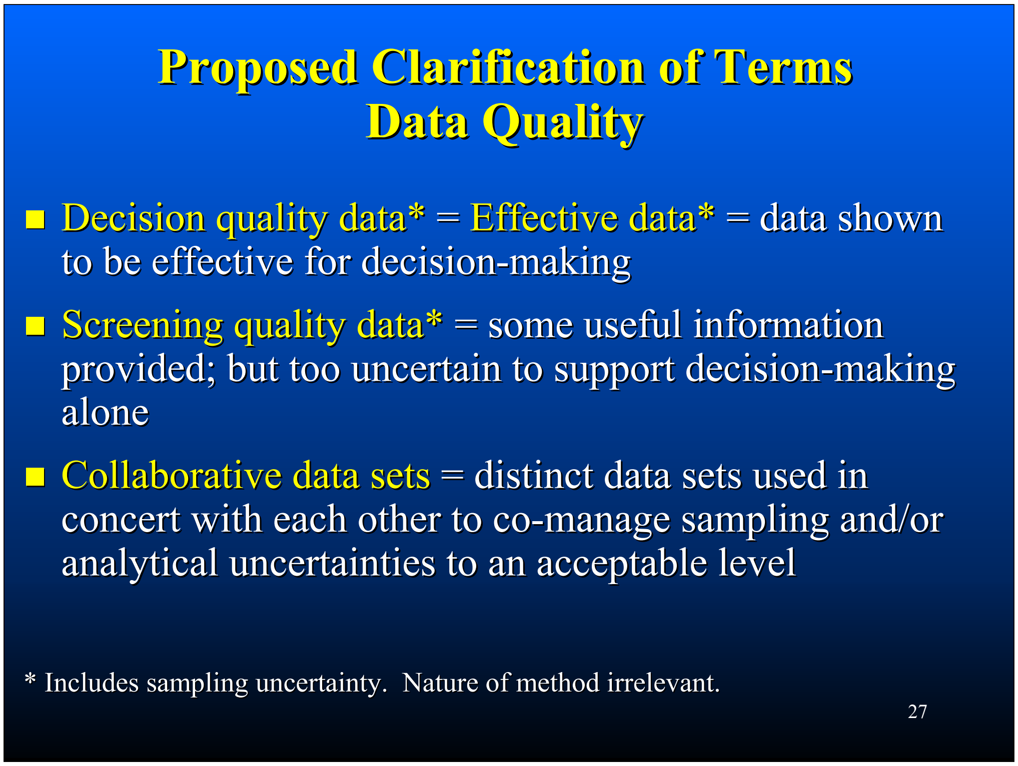


Quality assurance (QA) activities should focus on the explicit identification and management of uncertainties:

1) Project QA - explicitly organized around identifying the potential causes of project decision errors that are judged intolerable by the project manager or project mgt team, and then identifying and designing the strategies to manage the uncertainties that could lead to decision error.

2) Data QA – ensures that **both** the sampling and analytical uncertainties are explicitly managed to the degree needed to support the intended use of the data, and thus avoid making intolerable decision errors that could stem from inadequacy of the data sets.

3) Laboratory QA – Laboratory managers must ensure that the technical performance of analytical instruments, processes, and operators fall within acceptable limits to meet the quality goals of the laboratory. If the procedures used by the laboratory are designed to accommodate or correct for certain matrix interferences, or if the contract with the laboratory requires that sample-specific performance is guaranteed, then lab QA is relevant to the project data quality. If uniform, “routine” laboratory procedures are used that neither evaluate for, nor compensate for, sample matrix interferences, or if the data user requested that the wrong procedures be used, then lab QA is only partially relevant to project data quality. In those instances, good lab QA practice cannot be assumed to be equivalent to producing project-level data quality.



Terminology to express data quality concepts should focus on the ability of data to meet project decision-making activities, encouraging explicit identification and management of uncertainties in the data that could lead to decision errors:

1) Decision quality data = Effective data = data of known quality that can be logically shown to be effective for making defensible project decisions (because BOTH sampling and analytical uncertainties have been controlled to the degree necessary to meet clearly defined project goals). The nature of the analytical method (screening method vs. definitive method) is irrelevant.

2) Screening quality data = Data that provide some useful information, but sampling and/or analytical uncertainties about the data set limit the ability of those data to support defensible project decision-making on their own merits. Again, the nature of analytical method (screening vs. definitive) is irrelevant.

3) Collaborative data sets = It is possible that data sets (that by themselves would be considered screening quality) may become part of an effective data set if other data or information is available to manage residual uncertainty to the point where decision-making is defensible when this information is combined. This may sometimes be considered a type of “weight of evidence” approach. Using different techniques to manage various aspects of analytical or sampling uncertainty is often more cost-effectively than trying to manage all relevant data uncertainties using a single technique.

Transitioning to a More Modern Approach

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With 20 to 30 years of experience and technology development under our collective belts, we now have the knowledge and tools to accomplish site restoration and reuse much more cost-effectively and efficiently. The site restoration discipline is ready for a quantum leap toward a more mature industry that is solidly based on a more accurate understanding of how pollutants behave in the environment, on better technology tools to generate representative data (detect and measure pollutants and properties of the environment), and better technology tools to interpret data and share information. This calls for a work strategy that can readily integrate existing and emerging knowledge and technology at both the discipline level and at the project level.

Transition Steps

- **Articulate an overall vision and strategy to modernize site cleanup activities and programs**
  - View Triad pilot projects as both teaching and learning tools: perfect scientific best practice 1st, then write technical guidance
- **Revise and clarify the data quality model to match current scientific understanding**
  - Use intuitive terminology that avoids misconceptions, and that clarifies (rather than obscures) critical concepts
  - Conceptually link data quality to managing decision uncertainty
  - Retool common phrasing. Example: "Define the nature and extent of contamination **at the scale of decision-making**"
- **Educate about uncertainty management (decisions & data)**
- **Explicitly support multi-disciplinary project teams**

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Existing training materials for managing decision and data uncertainties can be found on the U.S. Department of Energy website at http://www.hanford.gov/dqo/training/cover.html

•DAY 1 - Managing Uncertainty for Environmental Decision Making

•DAY 2 - A Systematic Planning Process for Environmental Decision Making

TIO Efforts to Provide Support

- **Outreach– published articles (reprints available on Clu-In)**
  - Environmental Testing & Analysis article (Jan 2001)
  - ES&T feature article (Oct 2001)
- **"PM's Handbook of Triad Best Practices" (in development—pilot draft Web-available Aug 1, 2002)**
  - Hyper-linked Internet-based "how-to" map to existing guidance and technical information that support Triad implementation
  - The "Handbook" is designed to evolve and incorporate new ideas as practitioner and programmatic experience grows
- **Partnering with other experts/organizations:**
  - US Army Corps of Engineers (Handbook partner)
  - Argonne National Lab (technical support and practitioner expert)
- **Internet seminars: http://cluin.org/studio/seminar.cfm**
  - Archived or live

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ET&A article:
Lesnik, B. and D. Crumbling. 2001. Guidelines for preparing SAPs using systematic planning and PBMS. *Environmental Testing & Analysis Vol.10*, No.1. January/February. pp. 26-40. Electronic reprint available at http://cluin.org/download/char/etasaparticle.pdf

ES&T feature article:

Crumbling, D. M. et al. Managing Uncertainty in Environmental Decisions. *Environmental Science & Technology*, Vol. 35, No. 19. October 1, 2001, pp. 405A-409A. Electronic reprint available through Clu-In at http://cluin.org./download/char/oct01est.pdf

The Diffusion of Innovation

"At first people refuse to believe that a strange new thing can be done, then they begin to hope it can be done—then it is done and all the world wonders why it was not done centuries ago."

—Francis Hodges Burnett

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Thank You

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